AGRICULTURAL ENGINEERING

MARCH • 1956

In this Issue . . .

Engineer Offers Improvements in Disk Harrow Design to Meet New Requirements

How Flow Regimes Affect Hydraulic Behavior in a Drop-Inlet Spillway Tower

Irrigation Scheduling Guide Simplifies Task of Estimating Moisture Reserves

A Composite of Engineering Achievements —The Self-Propelled Hillside Combine

Electric Fence Operation Problems in Relation to the Strip Grazing of Livestock

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THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

New 12 Speed "300"

CASE

daringly different 3-plow design puts new meaning into performance

Painstaking research . . . inspired by the dreams and hopes of farmers and engineers alike . . . substantiated by years of grueling laboratory and field tests . . . followed by exacting standards of manufacture . . . has brought forth the dynamic Case "300"—the 3-plow tractor that sets a new trend in efficient utilization of power for amazing versatility of performance. Its myriad features also combine to provide handling qualities, conveniences and comforts never before known in any tractor.

Breath-taking in itself is the surprisingly simple, easy-shifting Tripl-Range transmission with 12 speeds forward and three reverse . . . ¾ of a mile per hour to 20 . . . for today's smoothest, steadiest transfer of power for any purpose from extra-heavy plowing to planting or highway travel.

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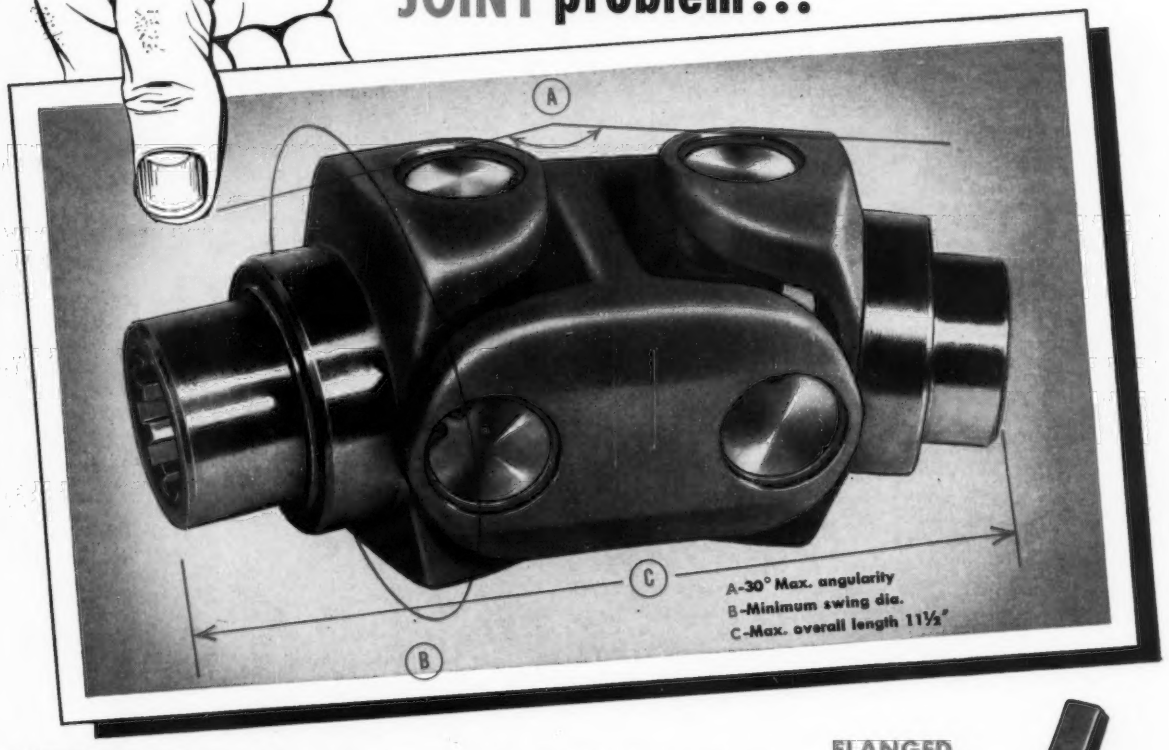
Horsepower presents thrilling new significance with the advent of Case Powr-Torq engines. Distinctly designed for gasoline, LP-gas, distillate or diesel . . . they pull normal load all the way down to half speed . . . with a peak of extra torque at two-thirds of rated RPM to move through tough spots without shifting gears.

To see and discover why the Case "300" is a symbol of advanced design . . . you are invited to visit the nearest Case dealer for all the facts about this revolutionary 3-plow tractor. Be among the first to learn why the "300" is the pacemaker of progress in modern power farming . . . how it facilitates the adoption of new farming practices. J. I. Case Co., Racine, Wis.

BLOOD BROTHERS helps solve another UNIVERSAL JOINT problem...

WHAT'S **NEW** AT BLOOD BROTHERS



PROBLEM: A well-known product engineering firm, designing a specialized mobile, diesel-driven machine, required special universal joints to transmit power to rubber-tired all-steering wheels. Joint length and diameter were limited by unusual space restrictions, yet heavy torque loads were expected at angles to 30°.

ACTION: As the designers had worked with Blood Brothers on universals for the unit's conveyor, they sent us experimental joints previously handmade for a larger machine.

SOLUTION: After study of the problem, Blood Brothers' engineers proposed certain alterations, resulting in production and tooling savings.

RESULT: Customer-supplier cooperation helped produce a non-standard joint which successfully meets both cost and operating conditions.

Very likely, your needs can be met with standard components, as Blood Brothers builds more types and sizes of universal joints than any other manufacturer. But standard or special, our engineers are willing and able to cooperate with you. Just write or call.

FLANGED STRAP-YOKE JOINT

In contrast to the heavy-duty joint above, it suggests the wide range of types and sizes offered by Blood Brothers.

For your convenience in specifying requirements, write for copies of this Blank Form "Specification Sheet". They're free!

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ROCKWELL SPRING AND AXLE COMPANY

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UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

AGRICULTURAL ENGINEERING

Established 1920

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A big step toward Better Farm Power—

Talk "Power Transmission" with Clark

For more than half a century the engineering resources and creative energies of Clark Equipment have been focused on this Vital Area of machine performance: Engine Power Transmission.

Several manufacturers of agricultural, industrial and automotive equipment are sharing the rich benefits of that specialization: benefits such as *more work done, lower cost of doing it, greatly reduced maintenance, longer-lived equipment.* These sum up neatly in "Better Value for a Dollar."

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For this is the new approach by modern engineering: To think not of component units, no matter how skilfully assembled—but rather in terms of a complete, integrated power-train of functional design to do a bigger job better and cheaper.

You can say this now of a growing number of modern machines—our own and others, for agricultural and industrial uses:

- From engine flywheel to point of torque application—power train designed and manufactured by Clark Equipment.

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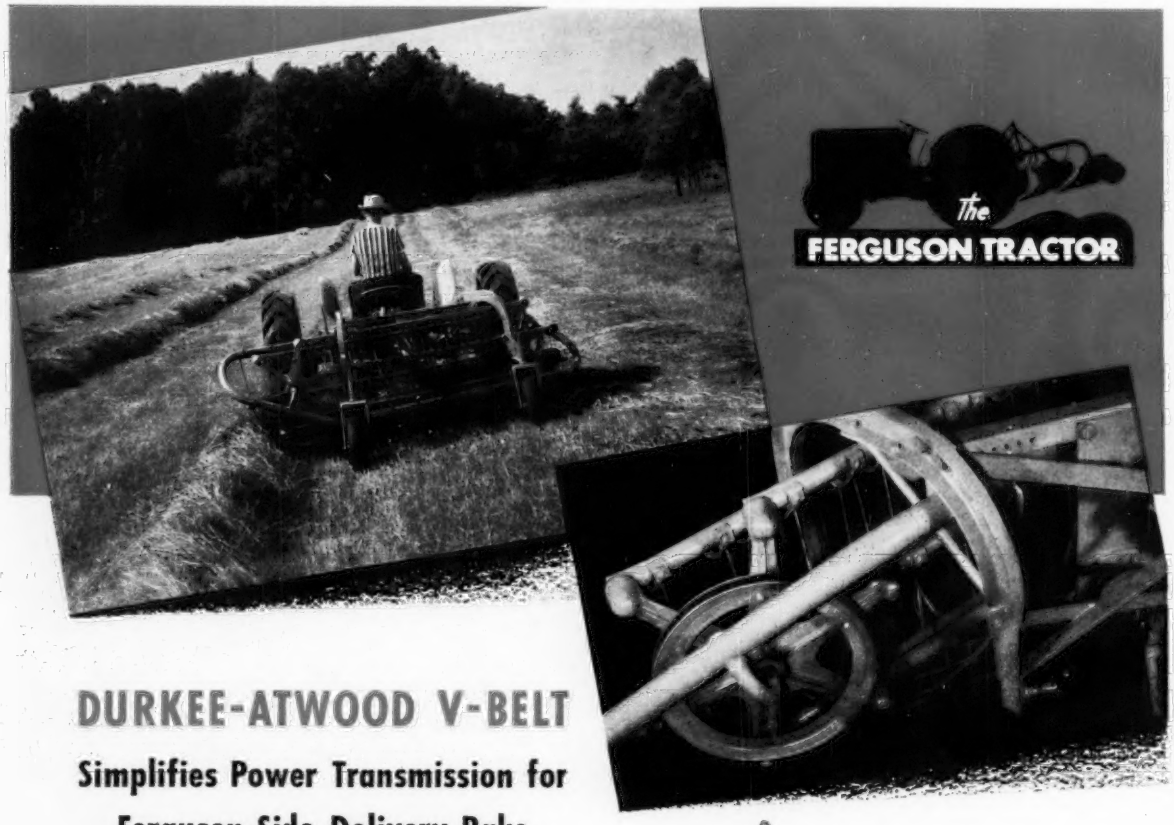

DURKEE-ATWOOD V-BELT

Simplifies Power Transmission for Ferguson Side-Delivery Rake

The Ferguson Side-Delivery Rake is unit-mounted on the tractor and driven from the power take-off by a single Durkee-Atwood V-Belt. This drives the right-hand reel spider with no cams, gears or chains to wear out or cause trouble, and eliminates the ground drive with its usual slippage and complicated moving, driving and wearing mechanisms.

The six-bar reel and special offset placement of bars permits raking at speeds up to 10 miles per hour. Should the reel become jammed accidentally, the V-belt drive allows sufficient slippage for protection.

D-A ENGINEERING Integrates the V-Belt with the Application

Durkee-Atwood engineers collaborated with Ferguson engineers in overcoming design problems of the V-belt drive for the Ferguson Side-Delivery Rake. The result was a specially constructed V-belt that does an outstanding job.

If you have a V-belt problem, Durkee-Atwood's facilities are at your command. Ask Durkee-Atwood—your best source for engineering assistance and highest quality V-belts for agricultural equipment.

Form No. 545

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8 INTERNATIONAL® STANDARD AND UTILITY TRACTORS

8 INTERNATIONAL CRAWLER TRACTORS

30 BASIC IH TRACTORS

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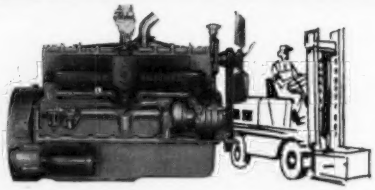
NOW . . . all types of engines

from one dependable source



L-HEAD GASOLINE — Compact and especially adaptable for installations where space is limited.

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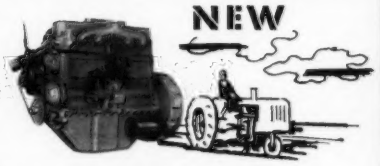
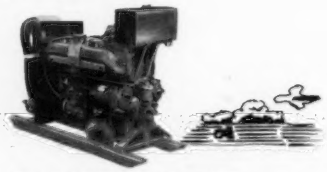
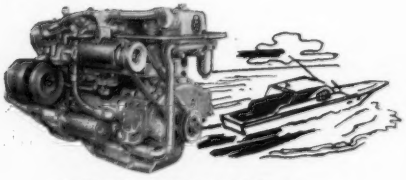


DD-SERIES — Direct injection Diesel. 12 models INTERCHANGEABLE with GO-Series gasoline engines.



L.P.G. NATURAL GAS or KEROSENE engines are available in 40 models also popular sizes for irrigation service.



MARINE DIESEL ENGINES — Sizes from 75 to 500 H.P. for workboats and pleasure craft.

PRODUCTS OF

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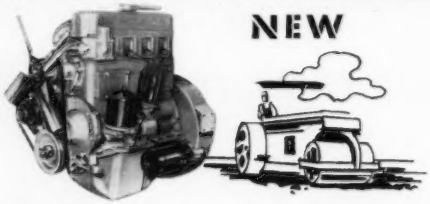
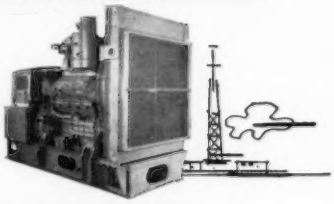
NEW

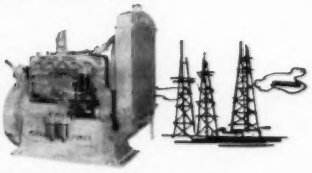


GO-SERIES — Gasoline Overhead valve engines. Available in 12 models.



SUPERCHARGED DIESELS — Maximum power for special installations such as micro-wave generator sets for coast-to-coast T.V.

TURBULENCE CHAMBER DIESELS — 32 models to 500 H.P. in 1, 2, 4, 6 and 8 cylinders.



POWER UNITS — Open, closed or base type units are available in most models of gasoline and diesel engines.

NOW . . . with the addition of the G O series (Gasoline Overhead valve) and the D D series (Direct injection Diesels), Hercules Motors Corporation offers a most extensive line of piston type engine to meet the varied needs of modern industry.

In addition to the many types of engines illustrated above, it is the policy of Hercules Motors Corporation to tailor engines to the special requirements of their manufacturing customers. Special versions of regular models — for example, "pancake" or flat engines — are often produced for particular applications.

Whatever your power requirements may be, HERCULES — Engine Manufacturing Specialists Since 1915 — will be happy to work with you and solve your power problems. For more information on the new G O and D D series — or any type of Hercules Engine from 3 to 500 H.P. contact the factory.

HERCULES MOTORS CORPORATION

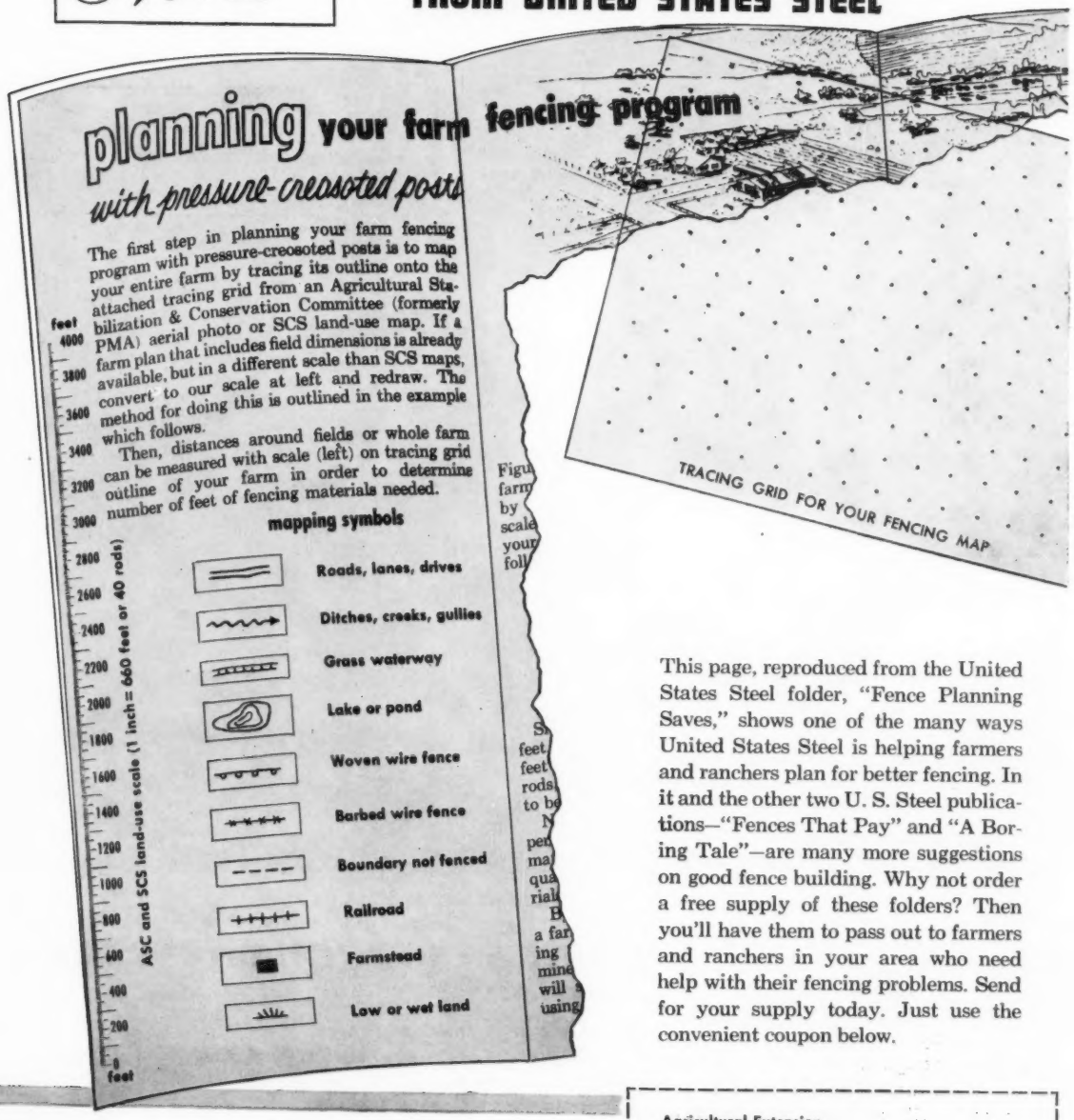
CANTON 2, OHIO

for the farmers and ranchers in your area:

TIPS ON BETTER FARM FENCING

No. 1

FROM UNITED STATES STEEL


planning your farm fencing program
with pressure-creosoted posts
The first step in planning your farm fencing program with pressure-creosoted posts is to map your entire farm by tracing its outline onto the attached tracing grid from an Agricultural Stabilization & Conservation Committee (formerly PMA) aerial photo or SCS land-use map. If a farm plan that includes field dimensions is already available, but in a different scale than SCS maps, convert to our scale at left and redraw. The method for doing this is outlined in the example which follows.
Then, distances around fields or whole farm can be measured with scale (left) on tracing grid outline of your farm in order to determine number of feet of fencing materials needed.
mapping symbols
Roads, lanes, drives
Ditches, creeks, gullies
Grass waterway
Lake or pond
Woven wire fence
Barbed wire fence
Boundary not fenced
Railroad
Farmstead
Low or wet land
ASC and SCS land-use scale (1 inch = 660 feet or 40 rods)
feet
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
feet
TRACING GRID FOR YOUR FENCING MAP

This page, reproduced from the United States Steel folder, "Fence Planning Saves," shows one of the many ways United States Steel is helping farmers and ranchers plan for better fencing. In it and the other two U. S. Steel publications—"Fences That Pay" and "A Boring Tale"—are many more suggestions on good fence building. Why not order a free supply of these folders? Then you'll have them to pass out to farmers and ranchers in your area who need help with their fencing problems. Send for your supply today. Just use the convenient coupon below.

And when you are advising farmers and ranchers about fencing, point out the economy of using pressure-creosoted fence posts. Remind them the slightly higher first cost of pressure-creosoted posts is offset by the many years of longer, trouble-free service. Creosote, when deeply impregnated into posts under pressure, often assures those posts a lifetime of 30 or more years, and renders them virtually impervious to attack by termites, dry rot, moisture, adverse weather or soil conditions.

UNITED STATES STEEL — USS CREOSOTE

UNITED STATES STEEL

Agricultural Extension
Dept. 5126, United States Steel Corporation
525 William Penn Place, Pittsburgh 30, Pa.

Please send me a free supply of the United States Steel folders on pressure-creosoted wood.

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Can You Find the Solution to a Chain Problem?

If you need help to find the answer to the chain problems of equipment design, the complete CHAIN Belt Line of agricultural implement chains has your economical answer.

Because CHAIN Belt has always stayed abreast... even ahead of your needs... you can find the answer you want in this complete line. And, CHAIN Belt engineers are constantly studying chain application problems of agricultural implements. Many new developments have been completed... more are under way.

Why not be sure you have the up-to-date solutions for your chain problems? Consult your CHAIN Belt District Sales Engineer or write CHAIN Belt Company, 4680 W. Greenfield Ave., Milwaukee 1, Wis., for your copy of Agricultural Chain Catalog No. 54-54.

CHAIN BELT COMPANY

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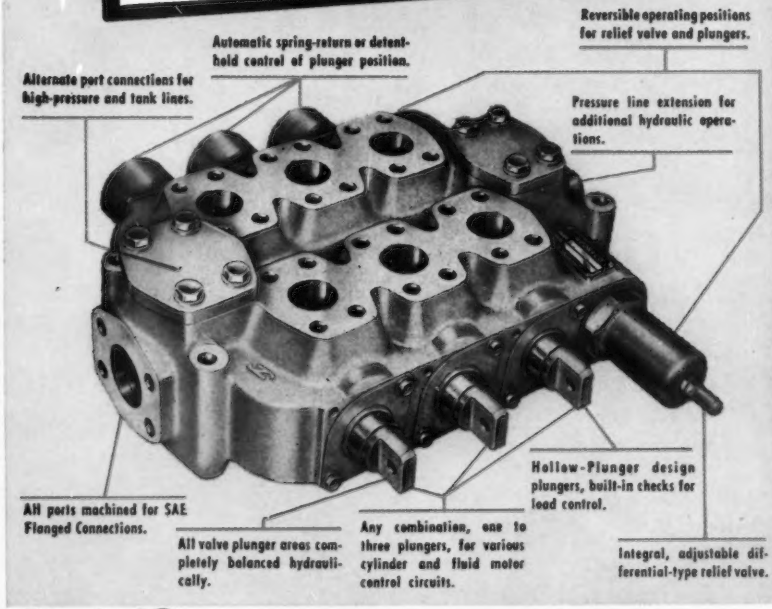
BIG VALVES FOR BIG JOBS

A New Series HYDRECO® HOLLOW-PLUNGER CONTROL VALVES

25-50-100 gpm to 2000 psi


Reversible operating positions for relief valve and plungers.
Automatic spring-return or detent-hold control of plunger position.
Alternate port connections for high-pressure and tank lines.
Pressure line extension for additional hydraulic operations.
Hollow-Plunger design plungers, built-in checks for load control.
All ports machined for SAE Flanged Connections.
All valve plunger areas completely balanced hydraulically.
Any combination, one to three plungers, for various cylinder and fluid motor control circuits.
Integral, adjustable differential-type relief valve.

Oil Power for BIG MACHINES

Built-in Checks to prevent load drop while shifting plungers . . . *Improved Throttling* for accurate control . . . *Complete Hydraulic Balance* of all plunger areas . . . this is the BIG NEWS in these new HYDRECO Valves for builders of BIG Machines. HYDRECO *Hollow-Plunger* Valves give hair-line control at *all* times, and, of vital importance with large machines handling heavy loads, there is no load drop when operating positions are changed — no sag, even when power is cut off!

These new HYDRECO Valves make single-acting or double-acting control readily available and provide control for Fluid Motors or for four-position float operation. Relief Valve adjustment and levers can be installed on either side of the Valve.

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Write for complete information on the new HYDRECO Control Valves and companion Hydraulic Pumps for your BIG JOBS.

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THE NEW YORK AIR BRAKE COMPANY

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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Fluid Power Speeds Turnpike Construction

CEILING ON CONSTRUCTION EQUIPMENT SIZES LIFTED

Modern turnpike construction calls for moving mountains or filling valleys . . . fast, and at lowest cost. To solve this problem, designers of construction equipment are creating machines that are bigger, faster and easier to handle than was believed possible only a few years ago. With every increase in size, weight and load the problems of operation and control multiply and exceed the ability of conventional hydraulic components to handle the job.

Engineers of The New York Air Brake Company faced this challenge and provided the answer . . . a completely new line of high capacity Gear Pumps and Valves. Today, design engineers can confidently employ circuits requiring up to 100 gpm and 1500 psi; thus lifting the ceiling on size, speed and capacity AND at realistic cost!

One of these big, new machines is the Euclid Model S-18 Overhung Scraper built by Euclid Division, General Motors Corporation, shown here. On this unit, Euclid engineers have specified big HYDRECO Pumps for fluid power and Series V28 HYDRECO Valves for control of scraper operations. A small HYDRECO Pump powers the hydraulic steering circuit. As big as these machines are, HYDRECO Oil Power gives them real "finger-tip" control.

The New York Air Brake Company also offers many other advanced type hydraulic components for designers of heavy-duty mobile equipment . . . DUDCO Dual-Vane Pumps to 150 gpm and 2000 psi; DUDCO and HYDRECO Fluid Motors; HYDRECO Control Valves and Hydraulic Cylinders.

ENGINEERS

Exceptional opportunities for men of imagination to express new ideas in the design and development of Hydraulic Components. Company expansion and progress in this growing industry promise rewarding futures for engineers who qualify. Write, giving experience and full details.

KALAMAZOO Division
The New York Air Brake Company
9007-3 E. Michigan
Kalamazoo, Michigan

Gentlemen:

I would like more information on the new HYDRECO Control Valves for BIG Mobile Equipment. ☐ Also details on HYDRECO 3600 Series Pumps. ☐

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Low stretch V-Belts improve

Farmers searching for faster, easier methods of handling grain, ear corn, bulk feed and other materials are finding the answer in Cardinal Elevators equipped with low-stretch Dayton Agricultural V-Belts.

Manufactured by LML Engineering and Mfg. Co., the Cardinal line is headed up by the versatile "Junior" constructed of strong, 15-gauge rustproof aluminum. An all-purpose elevator that's easy to handle and maneuver, weighing only 88 pounds in the 8′ size, the Junior even elevates bulk feed at 10-20 tph. Available with overhead or underslung motor mounts it is powered by either an electric or gasoline motor.

In field tests Cardinal engineers found that standard V-Belts stretched excessively. To work out the solution they consulted with Dayton V-Belt Engineers.

Further tests showed that the elevators were called on to handle a great range of loads up to and including full slug loads. Sudden dumping of heavy materials into the hopper resulted in tremendous drag on the V-Belts and a stretching reaction.

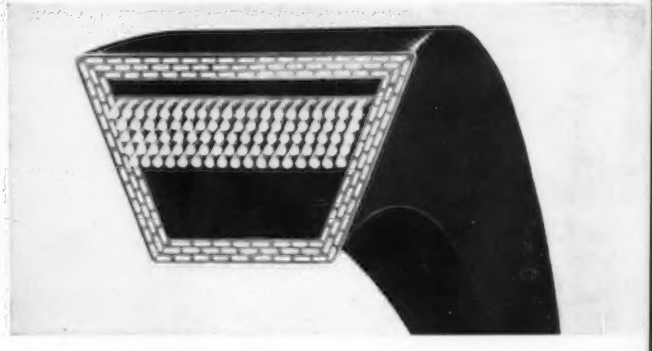
After studying necessary drive specifications Dayton engineers recommended, and Dayton laboratory technicians designed and constructed, a "B" section V-Belt with extremely low stretch characteristics to withstand the extraordinary loads.

Cardinal elevators, Dayton V-Belt equipped, were then field-tested. So well did they perform that Cardinal now equips their elevators 100% with Dayton V-Belts.

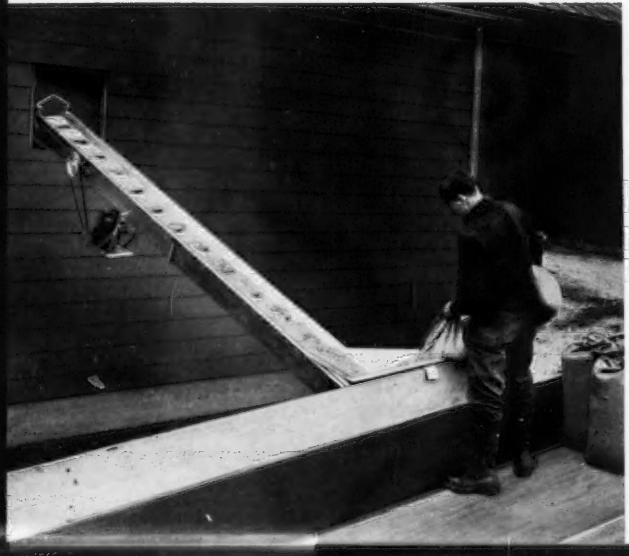
Whenever you have a problem in power transmission call on Dayton's experienced staff of V-Belt Engineers. Write Dayton Rubber Co., Agricultural O.E.M. Div., 1500 S. Western Ave., Chicago, Ill.

The Cardinal Junior is designed to handle a wide variety of materials, small grain, ear corn and bulk feed, with maximum efficiency. Aluminum alloy construction allows use in all weather without rusting. Grooved sprocket and cutter blade at the delivery end eliminate jamming, and easily installed intermediate sections make the Junior adaptable to most farm situations.

On conventional drives, where loads, speeds and pulley diameters are normal, the Dayton Agricultural V-Belt will meet your needs. If your design demands power transmission not practical with one of the thousands of standard V-Belts available, Dayton will design and build one to fit your specific requirements.



elevator efficiency



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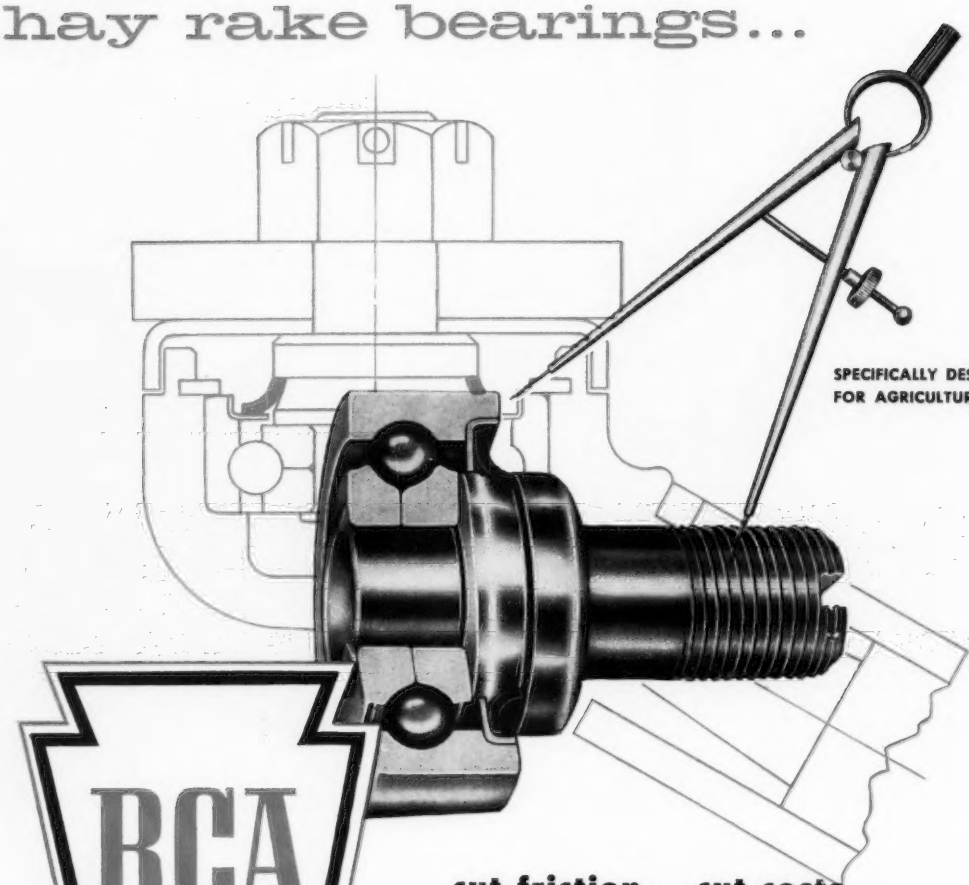
Dayton Rubber 51 YEARS OF PROGRESS

First in Agricultural V-Belts

Agricultural Sales Engineers in Chicago, Moline, Dayton, New York, San Francisco, Cleveland, St. Louis and Atlanta

package unit

hay rake bearings...



SPECIFICALLY DESIGNED
FOR AGRICULTURAL SERVICE

BCA

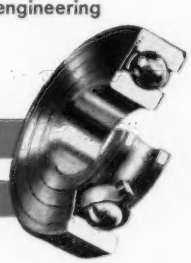
cut friction...cut costs...
cut installation time

As roller bar side-delivery rakes increase in popularity, farm implement manufacturers have been quick to recognize the advantages of BCA *package unit* Hay Rake Bearings. Design efficiency, ease of installation, and low cost, explain why these lubricated-for-life, triple-sealed ball bearing units have been written into so many specifications.

BCA *package unit* ball bearings have been thoroughly implement-proved in all kinds of weather, under all soil conditions. If you have a bearing problem, BCA design assistance and engineering cooperation will help you find the solution.

BCA

BEARINGS COMPANY OF AMERICA
DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.
LANCASTER • PENNSYLVANIA



Pioneers of pre-lubricated *package unit* ball bearings for agriculture

TRACK WHEEL BEARINGS ARE COMPLETELY PROTECTED

Whether it's tropical muck or crystal sharp Alcan dust, nothing sneaks past the C/R End Face Seals guarding the track wheels of this giant Oliver OC-18 Crawler. And here's why: The mating rings in this steel-on-steel C/R Seal are lapped flat within .000034 inch! They form a leakproof seal so dependable that even under the worst field conditions the oil and the bearings stay clean and the oil level does not require the usual frequent checking. Seal performance like this cuts downtime for lube checks . . . saves big money on round-the-clock operations. You can have equally dependable performance . . . and savings . . . with C/R Oil Seals.

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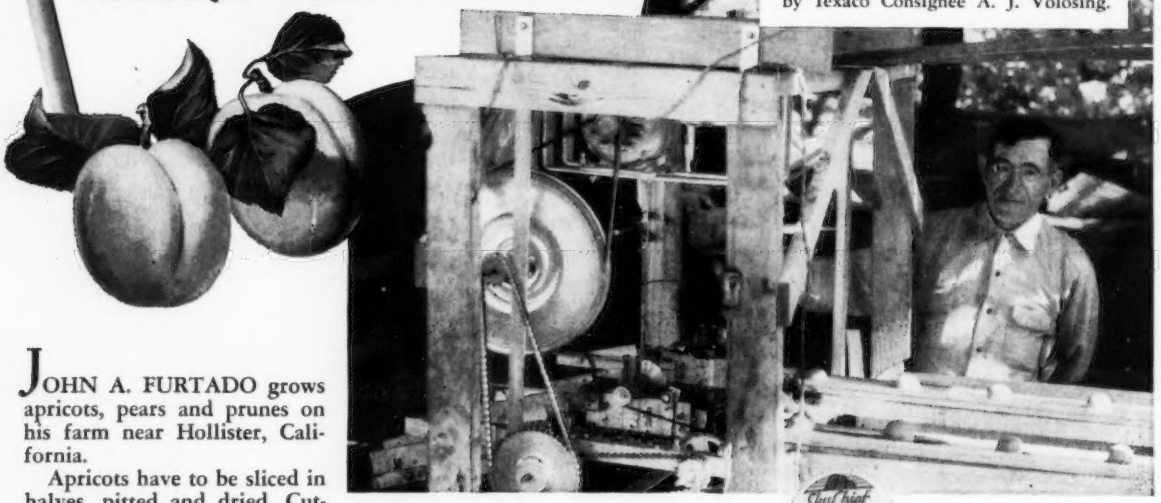
Fruit Grower HALVES LABOR COSTS with APRICOT PITTER



Side view of apricot pitter invented and developed by John A. Furtado of Hollister, California. Mr. Furtado is served by Texaco Consignee A. J. Volosing.

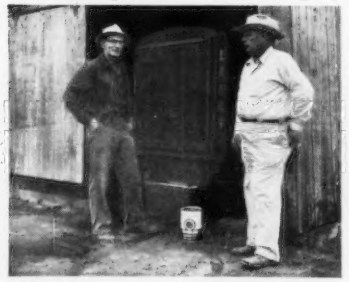
JOHN A. FURTADO grows apricots, pears and prunes on his farm near Hollister, California.

Apricots have to be sliced in halves, pitted and dried. Cutting and pitting was done by hand involving an expensive labor problem at harvest time.

Mr. Furtado had an idea that this job could be done by machine, and set out to invent one. After five years of experimentation and development, he succeeded.

With the machine illustrated, he cuts and pits two boxes (eighty pounds) of apricots in two and one-half minutes at a cost of about fifteen cents a box. The cost by hand labor was thirty cents. "The machine works equally well with peaches," he says.

Mr. Furtado, like keen farmers and ranchers from coast to coast, has found *it pays to farm with Texaco products.*



"This Le Roi engine has been running fifteen hours a day for eight years without needing an overhaul, thanks to Havoline Motor Oil," says G. D. Humphres *(right)*, manager of the H. Rouw Co.'s 1,475-acre farm near Carrizo Springs, Texas. At left is Melvin Mannering, farm service man for Texaco Consignee W. H. Dullnig.

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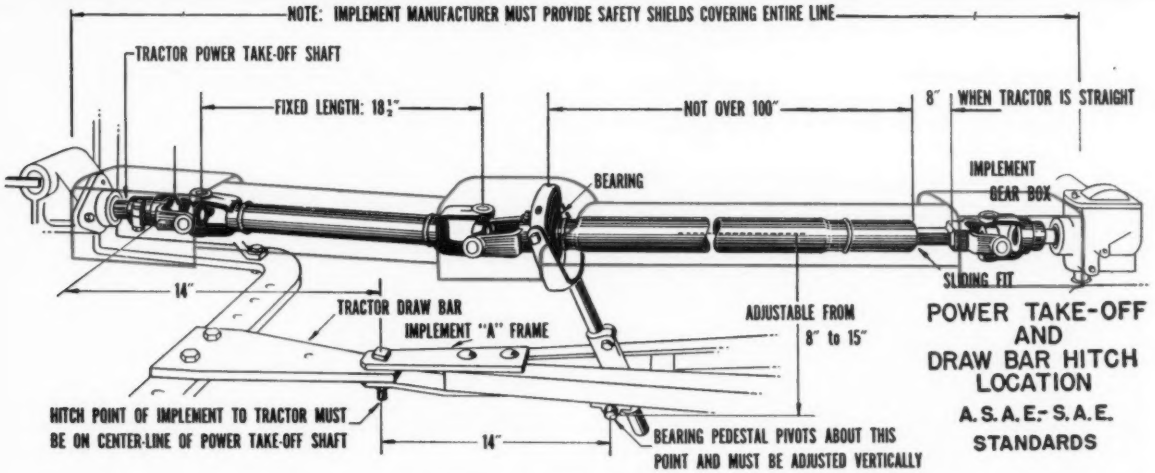
NOTE: IMPLEMENT MANUFACTURER MUST PROVIDE SAFETY SHIELDS COVERING ENTIRE LINE
TRACTOR POWER TAKE-OFF SHAFT
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NOT OVER 100"
8" WHEN TRACTOR IS STRAIGHT
BEARING
IMPLEMENT GEAR BOX
SLIDING FIT
14"
TRACTOR DRAW BAR
IMPLEMENT "A" FRAME
ADJUSTABLE FROM 8" to 15"
HITCH POINT OF IMPLEMENT TO TRACTOR MUST BE ON CENTER-LINE OF POWER TAKE-OFF SHAFT
14"
BEARING PEDESTAL PIVOTS ABOUT THIS POINT AND MUST BE ADJUSTED VERTICALLY
POWER TAKE-OFF AND DRAW BAR HITCH LOCATION
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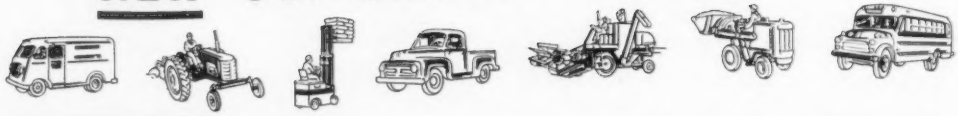
EXTRA Mobile Equipment News EXTRA
VOL. 2 VICKERS INCORPORATED, DETROIT, MICHIGAN NO. 6

NEW—For Smaller Vehicles



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Design is unusually compact and streamlined. Series S22 will go into a minimum space and usually requires little or no linkage change.

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All the "know-how" acquired in Vickers more than 25 years experience with hydraulic power steering has gone into the design and manufacture of the Series S22. Vickers hydraulic equipment of all kinds has a remarkable record of dependability. This booster is no exception.

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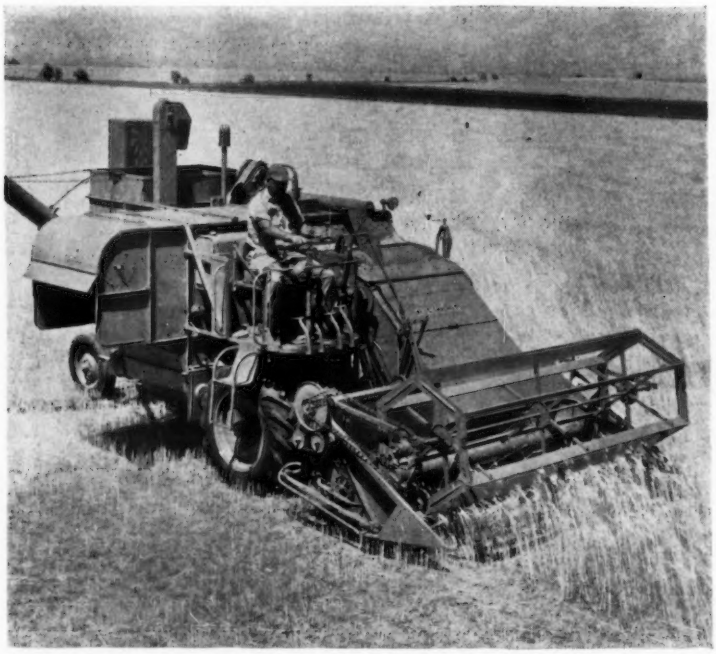
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

How behind-the-scenes services make Link-Belt chain a credit to your machine



It's Link-Belt double-pitch "AG" roller chain and Steel Link-Belt for the many power transmission and conveying jobs on this Allis-Chalmers Model 100 self-propelled ALL-CROP Harvester. The Link-Belt line includes cast, combination, forged and fabricated chains, roller and silent chain plus matching sprockets and attachments.

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THE services illustrated below are part of the exhaustive Link-Belt procedures that guide selection of the right chain for your machine. Link-Belt can make an unbiased recommendation because our line of chains, sprockets and attachments is *complete*. Every pertinent requirement is considered —horsepower, loading, fatigue life, speed, chordal action and many others.

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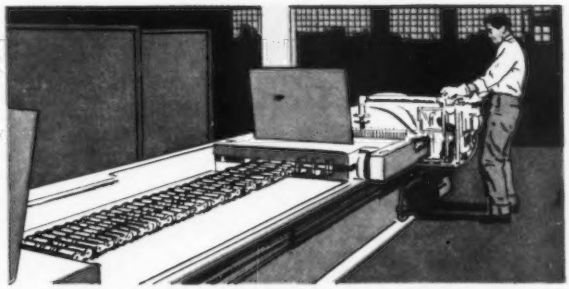

ACCURATE MANUFACTURE. Modern, specialized machines allow the economies of large-scale production. Continuous inspections safeguard tolerance and finish of every length of chain. With these extensive facilities, Link-Belt has ample capacity to meet your production schedules.

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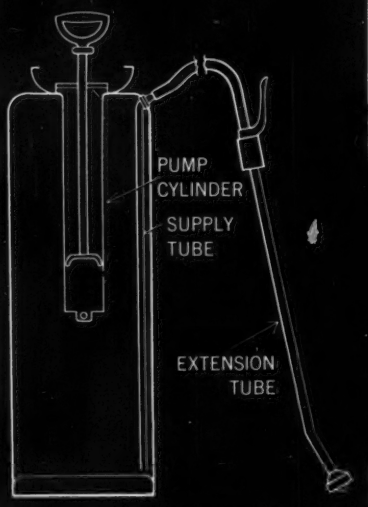

How Armco ZINCGRIP Tubing can help you gain Balanced Design

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All too often, ag engineers have had to specify high priced tubing to match the corrosion resistance of zinc coated parts of a product. Now you can gain balanced design with Armco ZINCGRIP Welded Steel Tubing.

Armco ZINCGRIP tubing is made from continuous hot-dip zinc coated steel strip. Outside weld beads on the tubing are planed off and the zinc coating renewed by a special metallizing process. This means that your customers get the same long life-expectancy from tubular sections as from other zinc coated parts.

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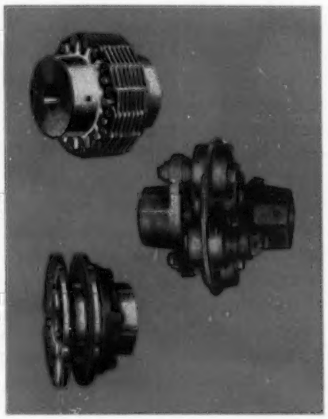

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Thomson Machinery Company
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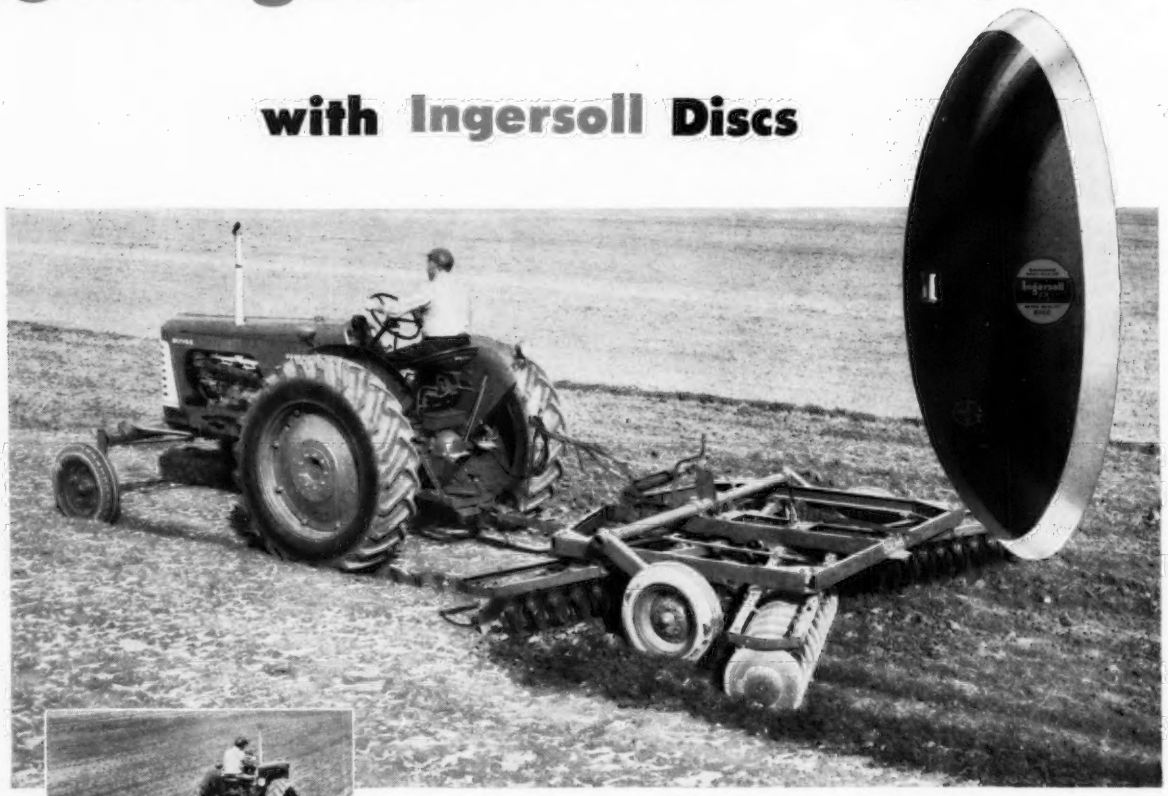
with Ingersoll Discs



Oliver No. 330 Disc Harrow equipped with Ingersoll Discs

Oliver Super 88 Tractor and PA-10 Disc Harrow with Ingersoll Discs

Above you see Oliver's new No. 240 Wheeled Tandem Disc Harrow teamed up with Ingersoll Discs for speedy seedbed preparation. Just a once-over trip and the job is done—vegetation and soil thoroughly pulverized and mixed—regardless of soil type or field condition.

It's a combination that eats up acreage, saves valuable field time, saves costly tractor fuel.

And those rugged, perfectly matched Ingersoll Discs really *stay* on the job. First, because they're made of Ingersoll's Tem-Cross® tillage steel that's *cross*-rolled for super resistance to impact and fatigue. And second, because they're heat treated by a special Ingersoll process that provides proper hardness without brittleness, eliminates warping, and adds extra toughness through and through.

And that's why all leading implement makers use Ingersoll Discs. To be sure of this same original equipment quality in the replacement discs you sell, order Ingersoll Discs direct from your own implement maker.

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AGRICULTURAL ENGINEERING

VOL. 37 MARCH, 1956 NO. 3

Disk Harrow Design Improvements

A. W. Clyde
Fellow ASAE

Farm implements perforce undergo changes to coincide with demands, conditions and tractor improvements. Of particular interest is the transition of the disk harrow to cope with problems incidental to width, transport and offset. This report deals chiefly with wide harrows and the tandem-bumper style, but illustrates one point concerning the pickup type and devotes some space to the offset harrow

DISK harrows are undergoing a change. The common type has always been inconvenient to transport, particularly if moving must be done over a paved road. It has been poorly adapted to making turns also unless equipped with means for straightening without backing up. To meet these objections, small tractors are being fitted with pickup disks. For large tractors, however, a disk which is wide enough to be an adequate tractor load is too heavy to be picked up and carried behind the tractor. The common practice for the large harrows is to make them as semi-trailers by providing two wheels for transport. Terms, such as "transport" or "wheel-controlled" are applied to them. Several companies are making them up to 15 ft wide, and one 21 ft wide has been announced recently.

The wide transport harrow would present little, if any, problem if it always worked on an even surface free from obstacles. The common style of such a harrow, however, is almost sure to do poor work on an uneven surface and to have trouble in fields having stones or stumps. Fig. 1 shows this common style in which the frame is in effect continued to the hitch point. The hitch point can be adjusted but has no flexibility. The tool is not well adapted to crossing low or high spots, and if an obstacle is struck, the load on one disk and its supporting parts can be extremely large. This situation is illustrated in Fig. 2. When the inner front disk rides over a stone, the entire tool is lifted. During a recent field operation, a 15-ft harrow struck a stone. After the hit, the tool was lifted, backed and the stone approached slowly. When one of the front disk blades was on the stone, the outfit was stopped. The rear gangs were out of the ground as in Fig. 2 and the disk blade on the stone was bent sideways 2½ in. This blade carried a load of over 3000 lb, not including impact. Such abuse causes broken blades, spools, bearings, bearing standards and other parts. Perhaps a tool can be made strong enough to resist such treatment, but a more sensible solution is to make the tool flexible so that it can yield to such obstacles. Another advantage of flexibility is that it permits a more complete job of disking on uneven ground. It also gives better trailing when crossing a low place diagonally.

Three kinds of flexibility are needed, as follows:

- Front to rear
- Torsional (or warping) of the frame
- Side to side.

These will be discussed in turn. It is recognized that some of the transport harrows on the market have some flexibility in one or perhaps two of these respects. Complete flexibility, however, is rare.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Power and Machinery Division. Authorized for publication as Paper No. 2039 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

The author — A. W. CLYDE — is professor of agricultural engineering, Pennsylvania State University.

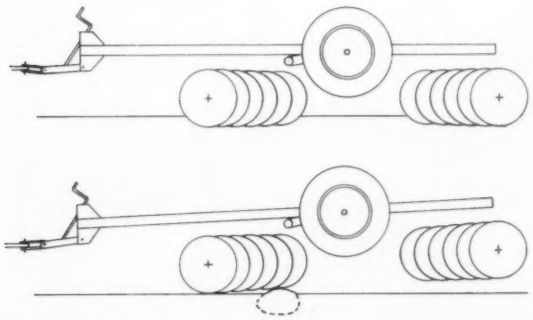

Fig. 1 *(Top)* A wide transport harrow with a rigid hitch. (Alternate disk blades omitted in the drawing.) • Fig. 2 *(Bottom)* Concentration of load on one or two disks when a harrow like Fig. 1 encounters an obstacle

Front to Rear Flexibility

Fig. 3 shows a harrow 12 ft 8 in wide equipped with a floating hitch. The disk blades shown are at the average position of front and rear gangs. When the tool is lowered, the hitch 1 is pivoted at *B* and the harrow has considerable freedom to conform to uneven ground. This harrow has been observed during the past two seasons in considerable

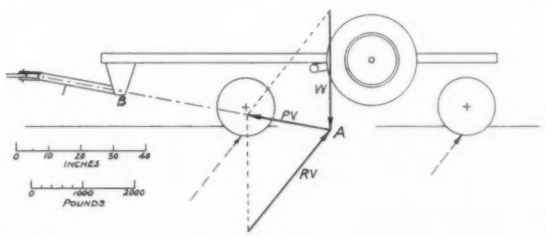

Fig. 3 A free-floating hitch with estimated forces in the vertical plane of motion. The disk blades shown are at the average positions of blades in front and rear gangs. *RV* has the typical angle for 18-in blades operated at an 18 to 20-deg angle

work in stony rolling fields and has considerable merit. In normal work the hitch takes an angle approximately as shown. The line of pull meets the weight line *W*, at *A*. *A* is therefore the point through which *RV*, the soil force on the entire tool, passes. If *W* is drawn to scale, then the values of *RV* and the pull *PV* can be found. The amount of *RV* which is applied to the front and rear gangs can be estimated by assuming they have the same direction as *RV*. In that case their values will be in inverse proportion to their distances from *RV*. It may be added that this represents a typical condition of the tandem disk harrow, the front gangs doing considerably more work than the rear.

Fig. 4 shows what happens when the front section passes over a stone. The rear section remains on the ground and the loads on the front parts are much less than they are with the fixed hitch. Similarly the rear section can go over the obstacle without lifting the front.

The floating hitch must of course be locked out when the harrow is lifted for transport. This is done as shown in Fig. 5 by using the movement of the axle. The hitch point is lowered relative to the harrow so that the harrow is kept substantially level in the transport position.

An extreme condition is illustrated in Fig. 6. Here the front section is passing over a 6 x 6-in timber, yet the rear gangs remain in the ground.

The pickup harrow shown in Fig. 7 uses another means of getting flexibility with 3-point linkage. *A*-frame (5) is attached to the tractor by members 1 and 2 and to the harrow by links 3 and 4. If there is no pressure in the lift cylinder, 1 and 2 are free links and the virtual hitch point is at the intersection of 1 and 2 extended. In much the same manner the harrow acts as if it were being pushed from the intersection of links 3 and 4. In the absence of an accepted term for this point, it will be called the virtual push point. The resultant force between the tractor and harrow is on a line connecting the two virtual points. Point *A*, where this line meets the weight line, is the point through which *RV* for the entire tool passes. The estimated division of *RV* between front and rear gangs is made as was done in Fig. 3.

If all of the links are free, this arrangement gives much flexibility as the tool goes over uneven ground. Another feature is that the penetration of the front and rear sections can be changed by adjusting the length of link 1. Shortening this link moves *PV* up, putting more dynamic loading on the front sections and reducing the loading on the rear. The opposite effect is obtained by making this link longer. Draft control or position control can be used with this hitch but the expected result will be less penetration and less work than with free links. If draft members 2 are held up by the hydraulic system, the virtual hitch point moves back and upward along the line of link 1 and away from the intersection of 1 and 2. This results in more upward pull on the tool and less penetration.

For transport, links 4 make contact with the frame cross member and the entire tool is then picked up. It may be added that this type harrow frame has considerable torsional flexibility, the next thing to be discussed.

Torsional Flexibility

In addition to front to rear flexibility, the common style of old harrow had another excellent feature. One end of a front or rear gang was free to go up or down without much

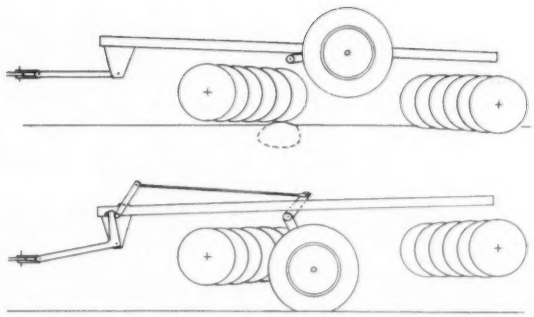

Fig. 4 *(Top)* The floating hitch permits the gangs to pass over obstacles without lifting the entire tool. • Fig. 5 *(Bottom)* Method of locking the hitch when the tool is raised for transport

disturbance to the other section. In contrast, the usual transport harrow has the gangs attached to a frame. The blades can accommodate themselves to uneven ground or to obstacles only if the frame twists or warps. A rough measure of this can be made by jouncing one corner of a harrow up and down when it is raised off the ground. If one of the adjacent corners follows closely the one being jounced, that indicates a rigid frame in this respect. A better method is to lower the harrow on a level surface and then see how high a corner can be jacked before another corner is raised off the surface. A variation of this latter test is to make it with the tool hitched to a tractor. The result is then a combination of torsional and front-to-rear flexibility.

Good warping flexibility requires that the members of the frame be flexible in torsion. Probably all designers know that pipe or tubing is stiff in torsion, while angles, channels and I beams are quite flexible. While this is generally known, there seems to be little distribution of more exact data, and the AISC steel handbook does not give the torsional properties of various sections. Textbooks by Den Hartog (1)* and by Timoshenko (2) explain the theory of torsion in non-circular sections and the Alcoa handbook (3) gives a torsional factor, *J*, for various sections. This factor replaces the polar moment of inertia in the formula for torsional deflection. This factor, like the polar moment of inertia, is a property of the section, not of the material. It can, therefore, be used with any material.

*Numbers in parentheses refer to the appended references.

Fig. 6 Front gangs passing over a 6 x 6-in timber without lifting the rear gangs

TABLE 1. COMPARISON OF STRUCTURAL SECTIONS
(Same weight per foot, except as noted)

SECTION	TWIST AT SAME TORQUE	TWIST AT SAME STRESS	BEAM STRENGTH
3" TUBE, 0.22" wall	1	1	1
3×3×5/16 ANGLE	60	5	3/4
3½×2½×5/16 ANGLE	60	5	1 1/8
3"-5.7 LB. I 6½% LIGHTER	80+	8¾	1½
3"-5 LB. [18% LIGHTER	80	5¾	1
3"-6 LB. [1½% LIGHTER	47	4¾	1 1/8
1"-5.4 LB. [11½% LIGHTER	80+	8⅓	2

Formulas for twist and stress of circular solid or tubular sections are

$$\theta = T/I_p E_s \text{ and } s = Tr/I_p$$

For an angle these become

$$\theta = T/JE_s \text{ and } s = 3T/bt^2 \text{ or } s = Tt/J$$

in which θ = angle of twist (radians per inch of length)

T = torque (pound-inches)

I_p = polar moment of inertia

E_s = shear modulus (pounds per square inch – approximately 11,000,000 for mild steel)

s = shearing stress (pounds per square inch)

r = radius of outside (inches)

$J = bt^3/3$

t = thickness of section

b = by Den Hartog this is the combined length of the two sides of an angle, while Timoshenko uses it as the combined length of the two sides minus t. Thus for a 3 x 3 x 5/16 angle Den Hartog uses b as 6 while Timoshenko uses it as 5 11/16. Values of J in the Alcoa handbook are apparently based on Den Hartog's method.

An angle in torsion has stress concentration in the fillet, Den Hartog's formula for this being

$$s(\max)/s(\text{avg.}) = 1.74\sqrt[3]{t/f}$$ in which f is the fillet radius in inches.

In Table 1 the stiffness of sections having the same, or approximately the same, amount of metal are compared, using the tube as unity. The comparisons, however, may be misleading unless properly interpreted. The large contrast in "twist at the same torque" is due considerably to the fact that the tube will safely take much more torque than the other sections, approximately 13 times as much as the angles if their yield strength is the same. In using the "twist at the same stress" it should also be realized that the other sections may have a higher yield strength than the tube, and thus permit more twist relative to the tube than that given. An angle made of rerolled rail, for example, would be expected to permit a higher stress than ordinary pipe.

Relative beam strengths in the vertical direction are also included since they need to be considered as well as torsion.

Apparently the advantage of a flexible frame in wide harrows has been known since most of these tools on the market have frames made of angles. Pipe and square tubes are being used in a few cases, however. Probably there is still room for improvement in providing the needed strength, yet keeping a high degree to torsional yielding.

Side-to-Side Flexibility

If a wide harrow is following a low place such as a deadfurrow, it bridges over the low place and leaves that locality unworked. The ideal would be to have joints that would permit the tool to accommodate itself to this situation. However, this is a hard requirement to meet in a practical way. Part of the problem is the fact that some degree of rigidity must be provided when the tool is lifted for transport. No doubt it can be done, but the difficulty will be to do it at a cost which will be within reason. Perhaps progress in this respect can be made if more thought is given to the forces acting on a single disk blade as is suggested in the next section. Perhaps, also, something can be done with virtual hinge points to get the pivot located at the best place.

Disk Fundamentals and the Offset Harrow

The offset harrow now is being fitted with wheels for transport. Understanding of this implement is practically impossible unless one appreciates certain facts about a single disk or a group of them such as one gang.

Attention first is directed to the upper gang in Fig. 8. For observation such a gang has been equipped with a platform at the front and rear at about axle height. Provision was made also for an adjustable hitch point. The gang then was pulled in the field with a chain at various positions and angles of pull until the gang kept a desired angle.

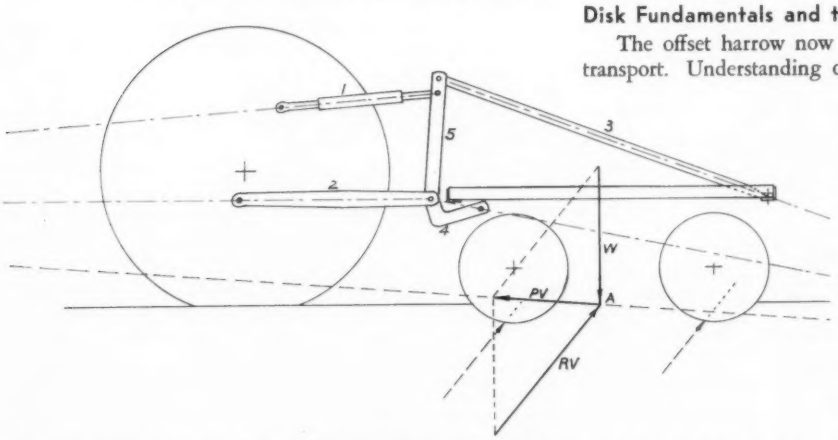

Fig. 7. Estimated forces in the vertical plane of motion on a tool having a virtual hitch point and a virtual pushing point. The loading on front and rear gangs can be changed by adjusting length of link

It was observed immediately that the right end of the gang went deeper. This was corrected by adding weight to the left end, moving the center of gravity to the left, away from the geometric center. After much experimenting, the balanced condition shown in Fig. 8 was found. Penetration was even and the pull, *PH*, passed through the geometric center or slightly to the right of that point. *PH* was the entire pull since no up or down component was applied.

In this condition the pull and the weight were balancing the total soil force on the disk blades. This leads to an important observation, namely, that since the pull and the weight lines do not intersect, the soil force must include two non-intersecting forces. Another way of saying the same thing is that the soil force consists of a force and a couple. Also, if the gang were looked at from the rear, the soil couple would be in a clockwise direction. The top of the disks try to roll to the right, the same way the soil is being rolled. This fact has been confirmed by many tests in the tillage meter on disk harrow blades run in the vertical position and at customary angles.

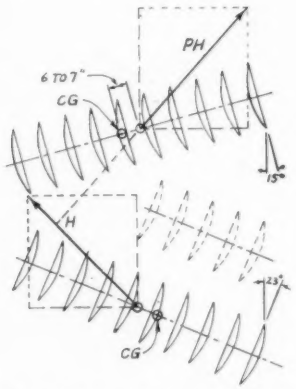

Fig. 8 A diagram to show certain basic facts about harrow gangs which, if taken into account, should permit more side-to-side flexibility, yet retaining even penetration

This basic fact now can be applied to an offset harrow. The balanced condition of the rear section is shown at the bottom of Fig. 8. In an actual harrow, however, the center of gravity of each gang will be practically at its geometric center. The right end of the front gang and the left end of the rear gang will try to penetrate deeply and will do so unless the frame connecting them is rigid in torsion or warping. Two conflicting requirements exist, *viz., (a)* a rigid frame to secure even penetration and *(b)* a flexible frame to permit accommodation to uneven land and to obstacles.

This conflict could be resolved in favor of a flexible frame if a way could be devised to center the total of all downward forces on each gang about points *CG* (Fig. 8). It has been suggested jokingly that one end of a gang be made of aluminum and the other end of lead. Seriously, however, in view of what is being done with linkages, there is hope that this problem can be solved so that a flexible frame can be used.

Another observation can be made about an offset harrow arranged as in Fig. 8. In this case the side forces are balanced, hence the tool can be drawn with a pull straight ahead of *H*. In ordinary field work as much offset as this is probably a drawback. The offset can be reduced by moving the right half of the rear gang up into the position shown by dotted lines. This will put *H* in a new location to the right and ahead of its former position.

Summary

In the future tandem disk harrows wide enough to be an adequate load for medium or large tractors probably will be largely of the semitrailer or transport type.

Such harrows, unless used at all times on smooth fields free of stones and stumps, need a considerable degree of flexibility for the following reasons: *(a)* to reduce shock and breakage on hitting obstacles, *(b)* to permit more complete disking of uneven ground, and *(c)* to give improved trailing when crossing low places diagonally.

Three kinds of flexibility are needed, *viz., (a)* front to rear, *(b)* torsional in frame, and *(c)* side to side. The first two are being provided in several harrows at the present time. However, it seems likely that more torsional flexibility can be obtained without higher cost if advantage is taken of knowledge about the torsional properties of various structural sections. Side-to-side flexibility is more difficult to provide, but is needed as widths are increasing.

It may be possible to make the offset harrow more flexible if more attention is given to the forces acting on a single disk or on one gang of them.

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A Correction

THE attention of readers is called to the following corrections in the paper, entitled "Effects of Electromagnetic Energy on Plants and Animals," by Baker, Wiant and Taboada, in AGRICULTURAL ENGINEERING for December, 1955 (vol. 36, pp. 808-812):

In the last paragraph beginning on page 810, the second sentence should read: "This process is dominant for photons with energies as low as 100 kev (kilo electron volts)."

In the second paragraph beginning on page 811, the abbreviation "kv" should read "kev" instead.

Rust Inhibitor

THE American Zinc Institute reports that metallic zinc paints are preferred where rust is present or where rust inhibitive qualities are demanded. Zinc pigments in metal-protective paints possess much the same rust-resistant qualities that galvanized steel does. These paints stick tightly and permanently to metal surfaces, are elastic, adjusting themselves to expansion and contraction in the base metal, and hide unsightly rust and stains. One gallon of metallic zinc paint will cover effectively 600 to 800 sq ft of metal surface. Metallic zinc paint is easily applied, has a pleasing appearance and provides low per year cost.

Flow Regimes of a Drop-Inlet Spillway

Gerald H. Nelson
Assoc. Member ASAE

THIS paper describes test work on a hydraulic model of a drop-inlet spillway tower. The results are intended to be qualitative and are concerned with the study and classification of flow regimes rather than with the analysis of a particular spillway tower geometry. Test results reveal that flow into a spillway tower may be governed by five head-discharge relationships.

A drop-inlet spillway is a type of structural spillway used mainly on farm ponds to pass excess inflow from storage and thereby maintain a desired pool elevation. The structure consists of three main elements: *(a)* a vertical conduit (tower) open at its upper end at the desired pool elevation, *(b)* a closed conduit to carry the flow under or through the dam to a suitable discharge point and *(c)* a transition section to connect the vertical and closed conduits.

Unfortunately, this type of spillway has been identified by as many as 18 different names in published literature and by common-usage titles in various localities throughout the country. The main points of controversy seem to be physical size and tower geometry even though all are identical in general hydraulic design criteria. This inadequacy in terminology has been pointed out in the event interested engineers wish to attempt to resolve this problem (1)*.

Recent works by Blaisdell (2), Minshall (3), Bradley (4), and Nelson (5) indicate that the use of this type of spillway is becoming more popular on both large and small waterstorage reservoirs. A bibliography of 170 references has been prepared as part of this study to serve as a guide for laboratory research. A paper by Rahm (6) dealing with the problem of flow at the entrance to Swedish hydroelectric plant intakes and tunnels is similar in many respects to work presented in this paper. As a separate part of his study, Rahm conducted model tests on thin-walled vertical towers of circular cross section in an attempt to classify and describe the flow characteristics. Tests reported here were conducted on a relatively thick-walled tower, square in cross section, in an attempt to again classify and note the pertinent flow characteristics.

The type of flow occurring at a given spillway stage appears to have a considerable effect on the instantaneous discharge rate (Fig.3). In order to point out this difference in discharge rate, a condition of free discharge was produced in the model tests described by allowing water to flow directly away from the base of the tower under atmospheric pressure. The data thus secured are not affected by the geometry of downstream hydraulic elements and the tests are merely an indication of the hydraulic behavior of a simple tower. Direct application of data and conclusions from this paper to the hydraulic design of drop-inlet spillways is therefore limited.

Hydraulic model tests show that the flow into a drop-inlet spillway tower may be governed by five head-discharge relationships

Apparatus, Procedure and Analysis of Data

A definition sketch (Fig. 1) shows pertinent geometric features of the model tower. The model tower should not be construed to indicate a practical design geometry. Normally the lip is rounded and the tower is fitted with an antiswirl wall in the interest of hydraulic efficiency. Also, in smaller reservoir applications, the tower is usually located in or near the dam to reduce the length of downstream closed conduit. Thus the approach depth is usually not large as indicated by the diagram. The lucite model tower was located in a specially designed elevated testing basin. The basin consisted of a large watertight tank with plywood walls and floor on a framework of welded steel shapes. The basin had inside plan dimensions of 13½ by 5½ ft. The walls were 3½ ft high and the model was located forward at a point equidistant from three walls of the testing basin.

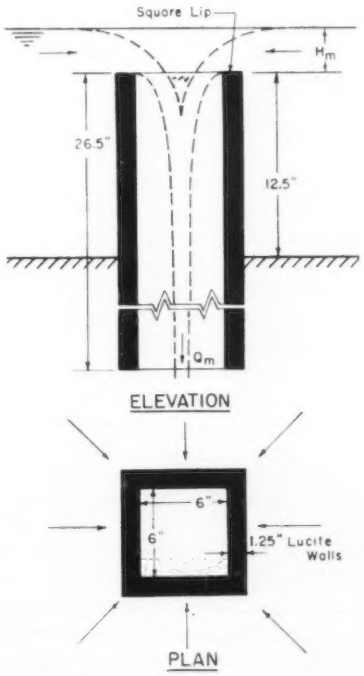

Fig. 1 Geometric features of a model spillway tower

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The author—GERALD H. NELSON—is formerly assistant engineer, Illinois State Water Survey Division, Hydraulic Laboratory Section, Urbana.

Acknowledgments: The laboratory work was conducted under the general supervision of H. E. Hudson, Jr. The author expresses appreciation to J. M. Robertson and H. E. Hudson, Jr. for reviewing the manuscript prior to publication. The study was sponsored by the Illinois State Water Survey Division, A. M. Buswell, chief.

*Numbers in parentheses refer to the appended references.

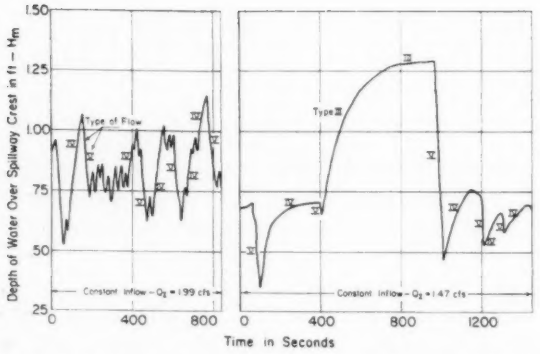
Depth of Water Over Spillway Crest in ft – H_m
Type of Flow
Type III
Constant Inflow – Q_i = 1.99 cfs
Constant Inflow – Q_i = 1.47 cfs
Time in Seconds

Fig. 2 Section of a typical recorder chart showing head-time variability during unsteady flow conditions

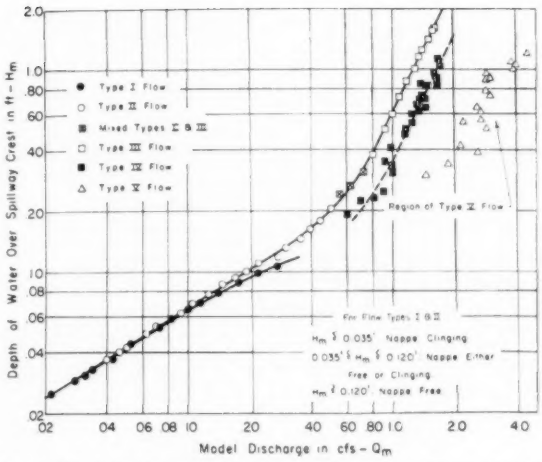
Depth of Water Over Spillway Crest in ft – H_m
Type I Flow
Type II Flow
Mixed Types I & III
Type III Flow
Type IV Flow
Type V Flow
Region of Type II Flow
For Flow Types I & II
H_m ≤ 0.035' Nappe Clinging
0.035' ≤ H_m ≤ 0.120' Nappe Either Free or Clinging
H_m ≥ 0.120' Nappe Free
Model Discharge in cfs – Q_m

Fig. 3 Head-discharge data for the model spillway tower showing effect of flow type

The rear 4-ft portion of the basin consisted of a chamber separated from the test area by a baffle of corrugated aluminum. Metered flow from a 6-in supply line discharged into this chamber and disturbances were damped out as the water flowed through the baffle to the tower.

Inflow to the basin was measured by an orifice meter with a series of three interchangeable (calibrated in place) plates covering a range of flow from 0.05 to 3.0 cfs. A small weir was used also to measure steady-state efflux for rates below 0.05 cfs. The supply of water was obtained by tapping into an overhead 12-in supply loop which is part of the laboratory's constant-head recirculation system (7). A point gage was used to "zero-in" the lip and also to take water surface contours of the approach flow and falling nappe. A standard hook gage located on one side of the testing basin served to measure the depth of ponded water over the spillway crest (H_m) when the head reached an equilibrium position. A Stevens type M laboratory stage recorder (activated by a 6-in float and with a 3-ft direct-reading range and electrically driven time drum) provided a record of fluctuating heads. Photographs of the flow into the tower were taken with a camera having a stroboscopic flash unit.

Readings were taken of the inflow to the testing basin and depth of ponded water over the spillway crest. When the model discharge (Q_m) fluctuated with time, instantaneous values of the head and its variability were measured by the stage recorder. All the data thus secured with the recorder and hook gage together with flow measurements constituted a test run. The analysis of data for conditions of steady-state discharge consisted merely of plotting the head (H_m) against model discharge (Q_m) and noting pertinent flow characteristics. However, when the discharge and head both varied with time, the recorder charts were used in an attempt to obtain approximate head-discharge relationships. A section of a typical recorder chart is presented in Fig. 2 to illustrate the procedure.

The slope of the pen trace at a given head is proportional to the rate of change of volume with time, i.e., the rate at which water is being added to or withdrawn from storage in the testing basin. The model discharge at a given head and flow type was computed by adding algebraically this storage rate to the constant basin inflow. The results of this procedure are plotted with the steady-state data in Fig. 3. The data have not been reduced to a dimensionless form.

From photographs of the flow into the tower and also from performance notes taken during the run, it was possible to identify the flow regimes which seemed to be causing the variability of the data shown in Fig. 3. In order to bring order into the description of the five observed flow regimes, Fig. 4 was prepared. In the discussion that follows some of the terminology used is arbitrary.

Type I, weir flow with clinging nappe, occurs naturally at low heads when water is just starting to flow over the crest. Air which initially is swept away back of the crest does not have a chance to reenter from the base of the tower. Despite all attempts, this type of flow could not be produced at heads above 0.12 ft. The slight increase in discharge rate as compared to type II flow may be the result of a low-pressure region back of the lip. Fig. 3 indicates that the head-discharge function for type I flow lies near the relationship for type II flow. Rotation due to vortex action increased with higher heads, but weir action over the spillway crest appeared predominately responsible for maintenance of this flow regime.

Type II, weir flow with aerated nappe, constitutes the regime most commonly observed. Its existence depends on a critical depth located either on or immediately upstream from the lip. Aeration of the falling nappe was complete and the head-discharge relationship in Fig. 3 was obtained for this condition since air could enter freely from the base of the tower. Vortex action increased as the head rose but like type I flow, weir action was the most predominate characteristic. H_m for this flow type (or regime) ranged from 0.035 ft, as a lower limit, to a head at which the impinging nappe produced a boil sufficiently high to generate its influence upstream. An estimate of the upper limit of H_m for type II flow could be approximated by observing in Fig. 3 the point at which the trend of type II flow begins to curve into the type III or orifice regime.

Type III, orifice flow, is the natural result of slowly increasing the basin inflow with type II present. Increased

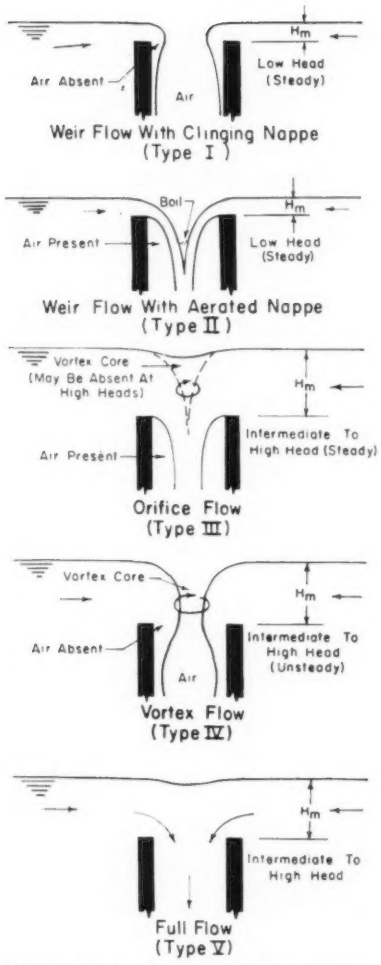

Fig. 4 Definition sketch of the five observed flow regimes at the entrance to a model spillway tower

vortex action was noted in the transition range between this regime and type II, although vortex action appeared less severe than with the type IV regime. The boil due to the impinging nappe lost its identity and a fully developed vortex core formed at heads above 0.35 ft. At heads above approximately 0.90 ft, fully developed orifice flow existed without a continuous vortex core. Vortex action was of course still present; however, its strength did not seem to be sufficient to produce a fully developed core with accompanying air intake. At even higher heads only a slight depression of the water surface over the tower was noted. The data points on Fig. 3 for this regime were obtained by slowly increasing the head and allowing sufficient time for an equilibrium condition to be established. As may be noted from Fig. 2, it is also possible to obtain an unstable flow condition if the head is increased rapidly.

Type IV, vortex flow, is produced and maintained by a vortex of relatively high strength over the mouth of the spillway tower. Possibly the centrifugal force generated from a combination free and forced vortex produces a local high-pressure zone which forces the flow against the interior

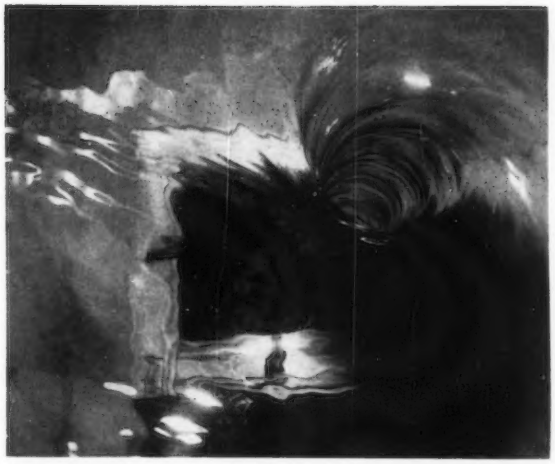

Fig. 5 Photograph of vortex flow. $H_m = 1.00$ ft and increasing rapidly. $Q_I = 2.32$ cfs. Large vortex core is continuous through the tower

walls and displaces air. Fig. 5 illustrates the spectacular nature of this flow regime.

Generally speaking, unsteady heads were typical of vortex flow (Fig. 2). Accidental variations in vortex strength seemed to cause head fluctuations even when the basin inflow was approximately equal to the model discharge rate. At high heads the vortex core became elongated and reduced in diameter and sometimes became temporarily choked off and type V or full flow occurred with a rapid increase in discharge rate.

Fully developed type V, full flow, occurs when air either from a vortex core or a pocket back of the lip is absent inside the spillway tower. At high heads the discharge rate with type V flow normally would be expected to be steady; however, the inflow to the testing basin (Q_I) could not be increased markedly to account for the increased instantaneous model discharge rate. Note from Fig. 2 that there is a sudden drop in head when type V flow occurs. The basin inflow normally was set at flow rates consistent with types III and IV flow. This indicates that a high percentage of the outflow is attributable to release from storage in the model basin.

When the vortex core of type IV flow became choked off at higher heads, flow sometimes occurred with loud gasping and sputtering noises with accompanying air entrainment. This type of flow is also classified as "full flow," even though this is an apparent contradiction in terminology. Visual observation during the tests indicated that the air flow inside the tower was confined to separated pockets rather than in the form of a continuous core.

Transitions Between Flow Regimes

The transition between weir flow (aerated nappe) and the orifice regime is shown in Fig. 3 as a solid curve. A continuous vortex core was observed which seemed to decrease in size as the head was increased slowly. No unique transition between the two types of weir flow and either vortex or full flow could be secured with the tower geometry tested. Data at lower heads near the vortex flow curve

(Continued on page 181)

Irrigation Scheduling Guide

W. O. Pruitt
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An easy-to-read irrigation guide shows at a glance the soil moisture conditions in various fields

VARIOUS procedures have been developed in the last few years whereby consumptive use of water by crops can be estimated for given climatological conditions (1, 4, 7)*. In recent studies rates of evaporation from a free water surface have also been used to indicate approximate rates of consumptive use (2, 5, 6).

Van Bavel and Wilson (8) suggested a simple bookkeeping method to be used in keeping a running record of evapotranspiration using average daily values for each month based on calculations by Thornthwaite's procedure (7). Krimgold (3) proposed the use of the same procedure based on daily values calculated from current weather data. In either case, continuous records would have to be kept for each crop in the various fields of a farm.

The purpose of this article is to discuss the mechanics of a more convenient method for applying consumptive-use data to schedule irrigation.

A simple irrigation scheduling guide (Fig. 1) which follows graphically the soil moisture conditions in various fields has been designed. It was used during the 1954 and 1955 growing seasons and greatly simplified the scheduling of irrigations for nine different crops, some of them grown at two or more locations in the Yakima Valley. Pan-evaporation data were used to estimate consumptive use of water by the crops.

The procedure consists of recording at frequent intervals (*i.e.*, daily) the cumulative value of pan evaporation throughout the growing season. A string stretched between two slides on the sides of the board provides the marker for indicating the current cumulative evaporation value.

The extent of soil moisture depletion in a field can be seen by a glance at the board. Individual slides for each crop and each soil are provided in addition to the pan-evaporation scale. To make up the individual slides, several factors are taken into account. The amount of water which can be removed safely by the various crops must first be estimated. Factors such as soil texture, structure and depth, as well as rooting habits of the crop, determine how much this is. Minor adjustments could be made, changing this amount to that which would be convenient to apply.

Since the relationship between consumptive use of water by crops and pan evaporation varies with size and type of pan used, the use by any one crop is not likely to be exactly equal to pan evaporation. The ratio between the two values must be taken into account. This is accomplished with the irrigation scheduling guide by using different scales for cumulative-evaporation values and consumptive-use values shown on individual crop slides. For example, 1 in on the evaporation scales is equal to 1¼ in of estimated consumptive use on the crop slides for alfalfa, indicating that for the evaporation pan used at Prosser, consumptive-use rates for alfalfa were 25 percent higher than pan-evaporation rates.

For procedures other than the pan-evaporation method of estimating consumptive use, crop factors or correction factors could be accounted for easily by the same procedure.

For operation of the irrigation guide, when a field is irrigated, the lower edge of its slide is put in line with the horizontal string. As evaporation occurs, the string is moved up each day or at convenient intervals. When the string reaches the upper end of any of the individual slides, depletion of the desired amount of soil moisture for that crop is indicated† and an irrigation would be applied, the amount of irrigation to be equal to that indicated on the slide. Following the suggestion of Gray, Levine, and Kennedy (2), in humid climates the amount of water applied during an irrigation could be limited to somewhat less than the indicated requirement in order to take advantage of any rainfall occurring within a few days after irrigation.

Adjustments for rainfall should be made where the rain is much of a factor. In arid or semiarid climates the rainfall can be taken care of by plotting cumulative evaporation minus cumulative rainfall. Rain can even be neglected in such areas without causing any appreciable tendency for overirrigation. In areas of higher precipitation, however, effective rainfall (rainfall minus run-off) would be esti-

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The author—W. O. PRUITT—is assistant agricultural engineer, Washington Irrigation Experiment Station, Prosser.

*Numbers in parentheses refer to the appended references.

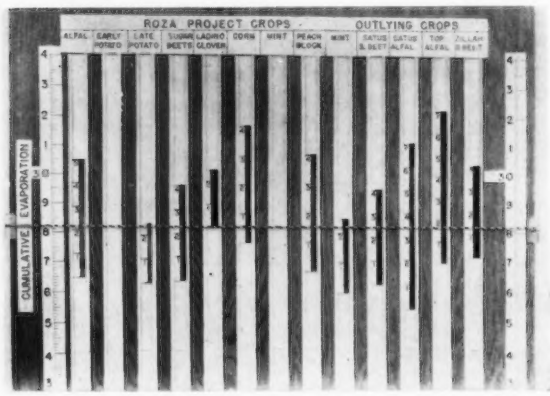

Fig. 1 The irrigation scheduling guide used at Prosser, Wash., during the 1954 growing season. Calibration of the slide under each crop varies in accordance with the ratio between consumptive use of the crop and cumulative pan evaporation for the area. The cross string is moved up as evaporation takes place. When the string reaches the top of any slide, that crop needs irrigation.

†Some allowances should be made for periods when the crop is not providing good ground cover as is the case with annuals for several weeks after emergence or alfalfa for a week or so after cutting. Consumptive-use rates for crops during such periods are considerably lower than estimated rates unless frequent rains keep the soil surface moist. In spite of the lower consumptive-use rates for annuals during such periods, more frequent irrigations may be required than the irrigation guide would indicate, since the root system of the young plants is limited.

mated and each slide moved up on the board accordingly. However, the bottom of any slide should not be moved up past the horizontal string, since deep-percolation losses normally would prevent a build-up of soil moisture above field capacity.

The irrigation guide could be produced commercially or be built by the farmer. He likely will need advice, however, from competent soil technicians of the U.S. Soil Conservation Service or his state agricultural extension service regarding best lengths of slides to use for each crop and soil.

Cumulative evaporation data (or estimated consumptive use) could be provided through local U.S. Weather Bureau broadcasts or through the state agricultural extension service by publication in local newspapers. It might be advisable for each farmer to obtain rainfall data from rain gages installed on his own farm since variation in precipitation is usually large whereas pan-evaporation data from one weather station would be likely to apply over a fairly large area. Individual farmers could maintain their own evaporation pan if they so desired; however, they would have to be careful in the placement of the pan and in the maintenance of the proper environmental conditions around the pan.

Summary

It is believed that the type of irrigation guide herein described can be used to advantage where estimated consumptive-use data are available. The farm operator would find it simple to operate once it was set up for him by irrigation technicians. Although it still would not make proper irrigation practice a simple task it would enable the farmer at a glance to estimate the moisture reserves still remaining in any of his fields. Periodic checks of actual moisture conditions within the soil profile likely would be advisable, not only to get each slide started in its proper position in the early summer but to check the correctness of the consumptive-use estimates and amounts of irrigation water actually applied.

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Flow Regimes of a Drop Inlet Spillway

(Continued from page 179)

(Fig. 3) were secured when heads were lowered from a higher elevation by reduction of the basin inflow. Similarly, data at lower heads in the full flow region were secured when the head was reduced from a higher elevation as a natural result of release from storage. There is, however, a tendency for data in the lower head regions of vortex and full flow types to point towards the start of the transition between weir and orifice flow.

Starting with weir flow with aerated nappe and increasing the basin inflow to produce a rapidly rising head, the vortex observed in the transition to orifice flow may be unstable. Usually a rapid jump to full flow resulted from this instability. A rapid jump from orifice flow at high heads to full flow was also observed. Full flow also resulted sometimes from heads built up by vortex flow. From observation of part of a typical recorder chart, shown in Fig. 2, it is found that the flow may oscillate between types III, V and IV, usually in that order. The basin inflow could also be adjusted to secure a continuous oscillation between vortex and full flow. A complete and detailed study of the cyclic phenomenon between the various observed flow regimes was not included in this study.

In Fig. 3 at $H_m = 1.0$ ft, the instantaneous discharge rate for full flow may be as much as three times the rate for orifice flow. After observing the extreme variability of the head-time function on the recorder chart, the scatter of data for types IV and V in Fig. 3 seems small. Type IV flow seems to have a better defined relationship than type V. With type IV flow, the rate-of-change of head with time was more gradual, and the errors in computing the storage rate were therefore reduced.

Conclusions

1 Five flow regimes at the entrance to the drop-inlet spillway tower can be identified from both visual observation and head-discharge data.

2 Attempts should be made to further investigate transient flow conditions during model studies on drop-inlet spillways.

3 The following statement seems reasonable but is here offered without proof: The hydraulic behavior of a spillway tower with change in geometric proportions also depends on which flow regime occurs.

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A Marvel of Engineering

The Self-Propelled Hillside Combine

D. C. Heitshu

Production of a self-propelled hillside combine was more than just a creation to satisfy a demand; it was a composite of several engineering accomplishments brought together to provide safe, efficient, non-tiring, one-man operation. This paper reports on the chain of events responsible for final production of a self-propelled combine by one farm equipment company

THE self-propelled hillside combine is not as new as some may think. On April 5, 1910, U.S. Patent No. 954,394 covering a self-propelled hillside combine was issued to Benjamin Holt. Records of the Holt company indicate that several of these machines were built in 1912. However, the farm economy of the West and Northwest was not ready for this innovation.

The idea of self-propelling a hillside combine apparently lay dormant until World War II and the postwar agricultural development popularized the level land self-propelled combine of conventional T configuration. The Northwest hill country ranchers used the regular self-propelled combine for opening fields, cutting roads in their fields, etc., even though the grain loss, due to the steep cross slopes, was excessively high. This use of the so-called push-header combine sold the Northwest on self-propelled combining, and the fertile inventive mind of the West went to work.

A rancher, Melvin Long of Dayton, Wash., first put together a self-propelled hillside combine unit with the T arrangement and a swivel feeder house. These two features identify all present-day hillside self-propelled combines. Mr. Long built his machine during 1948 and 1949. It had six drive wheels, steered by clutches, and the separator leveled by rotating within large rings. The chassis followed the ground slope and carried the header, so that no mechanism was needed to pivot the header platform. Mr. Long used this machine on his ranch for several years before replacing it with a production combine.

The first industry-built machine of current design appeared in the shops of the Harris Company at Stockton, Calif., in 1949. This machine was followed by a pilot group in 1950 and production in 1951. The Harris combine had the main frame, power plant and transmission a part of the separator. This necessitates a flexible drive from the differential to the drive wheels, and some means for rotation of the header to keep it aligned with the ground surface. This more conventional design has been followed by all subsequent machines.

With a sizeable group of combines working in the hills of the Northwest, a number of ideas were reduced to metal during 1951 and 1952, and within a short period of time additional machines were in the field.

Dave Neal of Garfield, Wash., made the first conversion of a John Deere 55 combine in 1951. This conversion moved the transmission and axle rearward and added swing arms

Paper presented at the national tractor meeting and production forum of the Society of Automotive Engineers at Milwaukee, Wis., September, 1955. Reproduced by permission of the SAE.

The author — D. C. HEITSHU — is chief engineer, John Deere Harvester Works.

Fig. 1 Rear view in field of John Deere Model 55H showing parallel-linkage steering-wheel axle

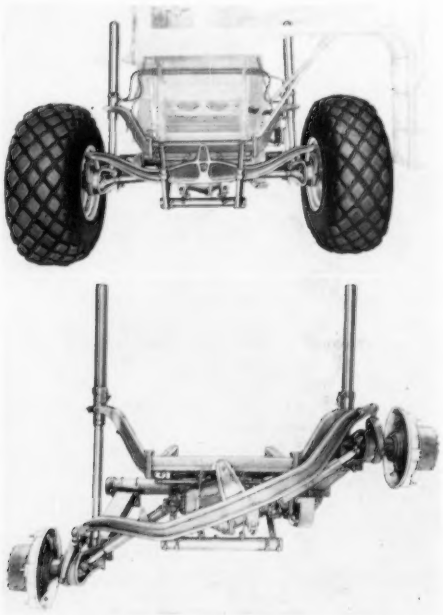

Fig. 2 *(Top)* Front view of Model 55H combine with header removed • *(Bottom)* Complete drive-axle assembly. The mounting and transmission interchange with that used on the level-land combine model. Disk brakes mount on sides of differential housing. Drive to wheels is through universal joints, slip tube, and 3.3 planetary in wheel hubs. Swing arms, leveling cylinders, and balance beam with gimbal ends are shown

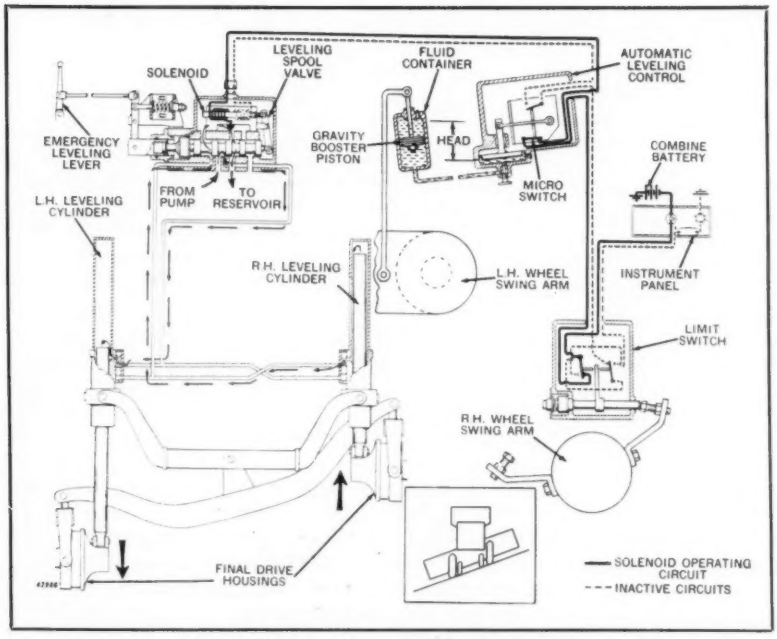

Fig. 3 Schematic of automatic leveling circuit

for the drive wheels, pivoting these arms on the transmission-drive axle. Drive to the wheels was through roller chain enclosed in the box-section swing arms. The swivel for the feeder house of the header was just ahead of the cylinder at the front of the separator. The wheels were interlinked and the header held to the ground line by a walking-beam structure around the header swivel. The leveling was accomplished by hydraulic power, with manual control, which actuated the swing arms. This was an excellent conversion and Mr. Neal made several hundred of these machines before the John Deere 55H hillside combine was placed in production.

The second conversion was the one built by the Hutton Brothers, of Edwall, Wash. In this the drive axle was pivoted about the axis of the differential-drive pinion to provide the lateral leveling of the combine. Although this unit could not level to the same extent as the Neal conversion, it was well liked in the rolling country, and quite a number of John Deere 55 combines were converted to the Edwall leveling system. The simplicity and cost of the Edwall change-over were in its favor.

At Moscow, Idaho, the third method of leveling the Model 55 combine was produced. In this arrangement the regular drive-axle tube was replaced by drive wheels supported on swing arms and driven through universal joints and slip tubes. The swivel ring for the header was placed between the header platform and the feeder house, and the cutterbar held in line with the wheels through a torsion-bar linkage. The leveling was controlled manually, using hydraulic power for actuation with racks and pinions for interlinking the opposite wheels. This hillside model also found acceptance and numerous conversions were made.

The fourth approach to leveling the Model 55 combine was made at Pomeroy, Wash. This unit had an open-chain drive, and although rather simple in design it did not meet with farmer acceptance.

Observing this rather sizeable group of hillside combines in operation indicated that the following requirements were essential to a satisfactory one-man self-propelled hillside combine:

- Automatic leveling
- Proper weight distribution for stability and safety
- Sturdy construction for safety and durability
- Power steering to reduce operator fatigue
- Good brakes for safe operation.

With these points in mind, the John Deere 55H self-propelled hillside combine was placed in the field experimentally during 1953. After minor changes the Model 55H went into full production in 1954.

The Model 55H uses the standard Model 55 separator, grain tank, engine, etc. For functional reasons the header swivel is located between the header platform and the feeder house. This enables the combine to have the regular feeding arrangement to the cylinder, as this is a critical relationship for efficient performance.

For alignment with the ground surface, the header platform is swung by a simple linkage actuated by the balance beam interconnecting the drive wheels of the combine.

The transmission and drive-wheel assembly, along with the leveling cylinders, constitute a complete unit which interchanges with the conventional transmission and axle assembly used under the level-land combine. In fact, many of the parts in the hillside transmission are identical with those in the level-land transmission. A planetary gear set is used in each drive-wheel hub to reduce the torque imposed upon the universal-joint drives from the differential to the drive wheels. Large disk brakes are mounted on each side of the differential to provide ample differential braking.

Automatic leveling is secured by using hydraulic power which is controlled by a hydrostatic head acting against a sensitive diaphragm. The diaphragm movement causes microswitches to make contact to energize the proper solenoid for the needed movement of the hydraulic valve which

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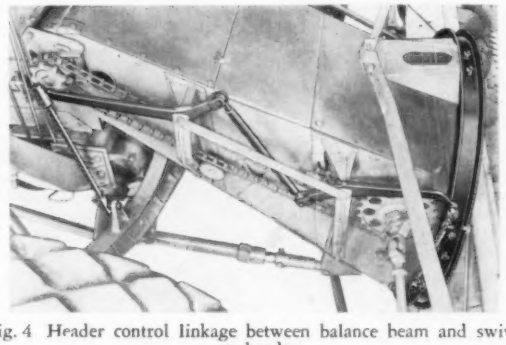

Fig. 4 Header control linkage between balance beam and swivel on header

Efficiency Factors in Electric Fence Operation

L. E. Campbell, G. R. Mowry and J. G. Hartsock
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Intensive or strip grazing of livestock presents special problems in the use of electric fence. This paper reports progress in the investigations now under way by USDA research agricultural engineers to develop methods and equipment for increasing the efficiency of this practice.

FOR more than twenty years factory-built electric fence equipment has been used in the United States. The idea of substituting one or two wires for a complete fence appeals to both farmers and persons with only academic interest; however, the conditions for providing charged wire which will give an effective shock and yet be entirely harmless have not yet been agreed upon. The engineering problems associated with the use of electric-fence systems are: *(a)* determination of the electrical characteristics of an effective shock as related to the energy limitations required for safety, *(b)* equipment for producing such an effective shock, and *(c)* conveyance of the effective shock to livestock with minimum energy loss.

Much research and development work has previously been done toward solving the first two problems (1, 2, 3)*. This paper, however, will deal with problems of conveying an effective shock to livestock.

Farmers are using electric fences for supplementing permanent fences, for temporary fences, and more recently for strip grazing. However, such use has not been without operational difficulties. The practice of strip grazing presents special problems in the use of electric fences, and this paper is, therefore, a progress report of investigations undertaken to develop methods and equipment suitable for this practice.

Strip or intensive grazing is the physical limitation of the area of foraging for daily or weekly periods. The principal advantage is better utilization of herbage to an extent that permits a 20 percent increase in cattle per acre of forage under some growth conditions. The size of the strip grazed varies over the season depending upon maturity of the crop, climatic conditions, agronomic factors, etc. Cattle may be confined to as little as 500 sq ft per cow at any one grazing period. Conventional rotated pastures usually have 15,000 to 20,000 sq ft per cow.

One method of strip grazing is shown in Fig. 1. This method requires a minimum of established fences and can usually be used without change of existing boundary fences.

Electric fences used in strip-grazing systems must meet two particular requirements. They must be readily movable, and they must resist unusually severe testing by the livestock. Since the fence is in a new location every day some cows will test it daily. Also, the close proximity of cows and fence results in more frequent contact at night. Because this close confinement of livestock requires more exacting performance of an electric fence, it also provides an excellent means of evaluating fence systems.

In 1954 the farm electrification section of the Agricultural Engineering Research Branch was asked to provide an electric fencing system to control cows in a rotation grazing experiment. For the experiment a 15-acre field was divided into one-acre areas as shown in Fig. 2. The entire field was bounded by a woven-wire fence.

A single barbed wire was used for the permanent electric fences. Eighteen-gage copper-weld wire was first used on the portable fences. This was later replaced with 13-gage aluminum. The larger aluminum wire is thought to be more readily visible to cattle. Barbed wire is also usable, except that the barbs require the use of gloves in moving and they catch in the grass when dragged.

Special portable posts were designed to support the movable fences, and these portable sections attach to the permanent fences by means of gate hooks. In designing the portable posts the following features were chosen as desirable:

- Post resting on the surface of the ground
- Post stable against upset by livestock or wind
- Wire attachment by means of integral catch without tools or additional wire clips.

These choices were based upon published reports from the United Kingdom (4) and upon the conviction that the daily moving of posts which must be driven into the ground, with subsequent attachment of wire, would be too laborious.

Several models were tried during the 1954 season. The most successful post is the one shown in Fig. 3. This post is constructed of ⅜-in steel rod welded so as to form a tripod. The post weighs 3 lbs, and several posts stacked together can be carried. At the top of the post a pigtail loop is formed from the ⅜-in rod. This loop is covered with a length of black polyethylene† pipe.

†Polyethylene is a thermoplastic resin made by the polymerization of ethylene gas under carefully controlled temperature and pressure. Proper compounding with black pigment is required to obtain resistance to weathering. The material is used on farms for cold water lines.

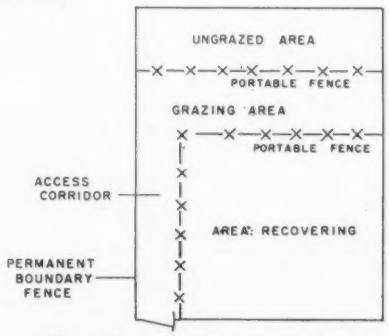

Fig. 1 A typical strip-grazing system

Paper presented (by J. G. Hartsock) at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Rural Electric Division. Contributed as progress report (ARS-42-2) of investigations by the Agricultural Engineering Research Branch in cooperation with the Dairy Husbandry Research Branch and the Field Crops Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

The authors — L. E. Campbell, G. R. Mowry and J. G. Hartsock — are research engineers, farm electrification section (AERB, ARS), U.S. Department of Agriculture.

*Numbers in parentheses refer to the appended references.

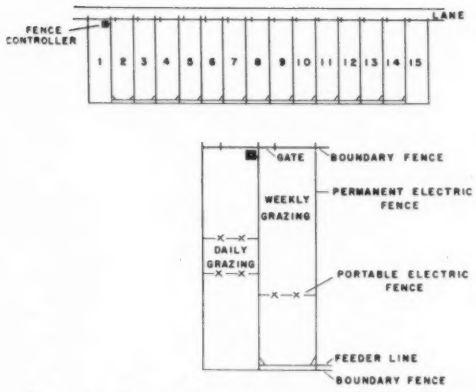

Fig. 2 A 15-acre field divided into one-acre areas for strip-grazing experiments

The exact dimensions of this post are not critical. Longer supporting legs with wider spread will give greater stability; however, the post will be more bulky. The height will depend somewhat on the crop and livestock being controlled.

The use of polyethylene insulators which clamp on the post and which are adjustable in height is even better. Fig. 4 D shows such an insulator as sold commercially in England. This is a simple fence connector that represents an ingenious low-cost design.

The portable posts gave satisfactory results, except there were occasional breakthroughs by the cattle. There is some evidence to indicate that control of livestock by electric fence is more effective with barbed wire than with smooth wire, all other factors being equal.

Portable fences on the posts described or on regular ground-driven fences are stretched by hand. This is less taut than desirable but does make for easy movement. However, a tight wire helps resist breakout. The British (4) have a small hand-tightening take-up reel for electric fences. A similar device is sold in hardware stores to tighten the backyard clothesline. These units are somewhat usable but the main difficulty is the winding of the fence wire on a small-diameter reel. Wire thus taken up is difficult to stretch when an increase in length is required. A lightweight flexible chain or cable attached to this type tightener would result in a low-cost unit (about $1 retail).

During the erection and subsequent use of the experimental fences during the season, checks were made with a "megger" (megohmmeter) to locate shorts to ground. From these occasional checks it became apparent that under wet conditions, the resistance to ground of the entire system was less than 100,000 ohms. With the controller being used, 100,000 ohms is the point at which further decrease in fence resistance dims the neon light, indicating fence short. When the resistance decreases to about 3,000 ohms the light is not visible. Actually, in daylight in the field it is difficult to see the indicating light with resistances below 50,000 ohms. Records of breakout of stock were limited; however, there were indications that breakout occurred at night or early morning when wet conditions existed from dew or rain. Checks or resistance to ground of the fence indicated as low as 30,000 ohms. The portable fence post sections using polyethylene insulation maintained high resistance to ground.

The differences in resistance to ground measured during the 1954 season between the polyethylene insulation and the porcelain insulators, as well as the differences between humid and dry conditions, indicated a need for additional study, so these aspects were more extensively investigated in 1955. Variations due to humid conditions have previously been reported by Dalziel (1), Riley (3), and Nicholas (5). Arrangements were made to purchase a supply of polyethylene insulators direct from England for field tests. The same layout of the field (Fig. 2) was used in 1955. The permanent cross fences had 17 posts each with a strain insulator at each end, a total of 19 insulators each. The cross fences were connected to the feed line by battery clips to permit easy disconnection for individual section measurements. The portable posts equipped with polyethylene insulators were again used on the movable fences.

Since it was impossible to obtain the polyethylene insulators by the beginning of the 1955 season, tests were begun using porcelain insulators only. All broken or chipped insulators were replaced and the fences were kept free of vegetative growth. Resistance measurements were taken with a megger under field conditions with cattle using pastures daily. In terms of a mile of fence (the approximate total of all sections) the resistance of the porcelain system to ground was 5,000 to 50,000 ohms under wet conditions, and 4 to 25 megohms (megohm=1 million ohms) under dry conditions during the months of April, May, and June.

Early in June the insulators on one-half of the fence test sections were replaced with British polyethylene models. Two types of post insulators and a common type of strain insulator were used. The insulators are shown in Fig. 4 (A, B, and C). One type of insulator (A) is very similar in dimensions to conventional porcelain insulators. The other type (B, "butterfly") has considerably greater surface from wire to ground. These insulators are commercially manufactured in England.

Table 1 compares the resistance to ground of porcelain-insulated fence sections and polyethylene-insulated sections.

TABLE 1

	Resistance to ground (megohms)					
	Wet (above 85% humidity)			Dry (below 50% humidity)		
	Max.	Average	Min.	Max.	Average	Min.
Porcelain (April-October)	—	0.08	0.01	300+*	65.0	—
Polyethylene A (June-October)	—	2.4	0.15	300+*	300+*	—
Polyethylene B (June-October)	—	8.0	0.5	300+*	300+*	—

*Upper limit of accurate measurement.

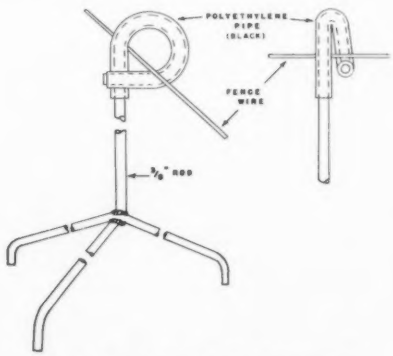

Fig. 3 A portable electric fence post

The combined tests represent measurements in the field from April to October, 1955, for porcelain and from June to October, 1955, for polyethylene. Fig. 5 shows the variation of section resistance with humidity.

Weather conditions included approximately 15 in of rain accompanying two hurricanes during August. No breakout of livestock occurred on the sections of fence using polyethylene insulators. Additional trials will determine if this was due to improved insulation.

The measurement of so wide a range of resistances under outdoor conditions presents many instrumentation problems, so a series of measurements were also made in the laboratory under better controlled conditions.

The electrical-insulation quality of insulators which is of concern in electric fence use is the surface-insulation resistance. This is a combined function of area and of "surface resistivity". Surface resistivity is the resistance between two opposite edges of a surface film 1 cm square and is dependent upon a thin film of moisture, sometimes commingled with dust or foreign matter on the surface of the insulating material (6).

To compare the surface resistance of various types, individual insulators were placed on posts outside the laboratory with individual wires attached. These wires extended inside the laboratory so that measurements could be taken more easily without weather difficulties. The leakage resistance of the units is shown in Table 2. These values are for the fence insulators as normally used rather than per centimeter of surface area.

Although measurements of resistance of individual insulators were taken from June to November, the tests of November 17 and 19 shown in Table 2 represented the highest and lowest readings of the season. November 19 was wet with a combination of wet snow and rain at approximately 33 F, while November 17 was dry, temperature 45 F, relative humidity 20 percent with a brisk drying wind.

TABLE 2

Surface Resistance of Individual Insulators (megohms)	Nov. 17—Dry	Nov. 19—Wet
Porcelain (New in April)	33,700	6-13
	33,700	5-13
Porcelain (New Nov. 1)	461,000	4-40
	403,000	75-145
Polyethylene (A) (New April)	290,000	4-32
Polyethylene (B) (New Aug. 15)	750,000	286
Polyethylene (B) (New Nov. 8)	290,000	300-1030

The approximate distance from wire to ground as normally used is porcelain 1.0 in, polyethylene (A) 1.25 in, polyethylene (B) 1.5 inches.

Discussion

The effective control of livestock is based on several factors in addition to the controller and its output leads. Lightning arresters, insulators, wire, plants, and moisture in both air and soil are important. The use of better insulators is one means of improving performance of electric fences. The replacement of porcelain with improved insulators such as type B polyethylene would result in average resistance to ground 10 times the present values in field use. As projected from data shown in Fig. 5, on a weed-free fence the resistance of a mile of polyethylene-insulated fence (200 insulators) would not fall below 100,000 ohms until the humidity is above 90 percent. Porcelain from the same chart will drop below 100,000 ohms at about 80 percent relative humidity.

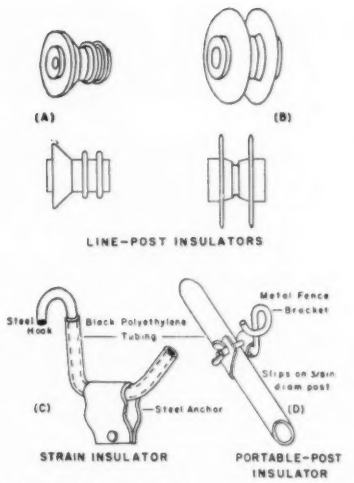

Fig. 4 Black polyethylene fence insulators

Plant growth touching the wire will greatly reduce the effectiveness of electric fences. In the tests reported it was necessary to physically remove grass or weeds touching the fence wire. The control of such vegetation along an electric fence is essential. In pastures it is plants such as orchard grass and timothy that give the trouble. If the area is well matched to the number of cattle, the grazing of the cattle will be effective in confinement, as they will inevitably graze the areas under the wire and around the perimeter first. Areas harvested mechanically can be grazed for a day to clean up uncut areas at the edge where the growth is under permanent electric fences. The use of portable posts offers little difficulty from vegetative growth unless the growth reaches a height above which a wire would be too high for cattle. If crops more than 30 in high are being strip-grazed, mowing of a path for the fence is required. Normally the portable fence does not remain in one location long enough for weeds to grow up and touch the fence.

As the insulation resistance of electric fences is increased, the characteristics of the system become increasingly similar to those of a capacitor. The possible effects of this circum-

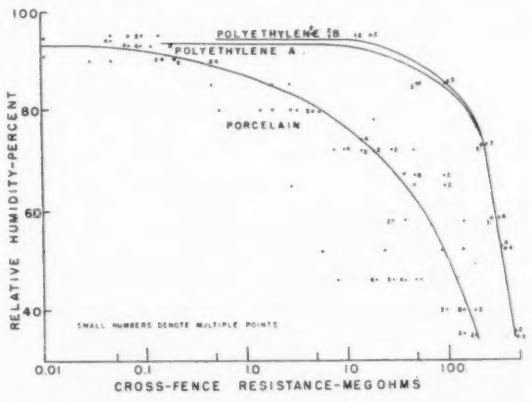

Fig. 5 Variation of cross-fence resistance with humidity, comparing polyethylene and porcelain electric-fence insulators

stance should be investigated more thoroughly. It is conceivable that the use of improved insulators, such as polyethylene, might increase the energy storage of fences through capacitance to a degree which might require a revision of present concepts of desirable characteristics of controller output.

Recommendations

Four types of insulators are required for use in electric fences:

- Strain insulators for the ends of the fence
- Line insulators for permanent fences
- Line insulators for portable fences
- Gate insulators used in access gates.

All types of insulators should have the following characteristics:

- Material of high surface resistivity under conditions of 90 percent humidity, equal to or better than polyethylene
- Volume resistivity equal to porcelain under conditions of 90 percent humidity.
- Physical shape which provides maximum path of surface leakage and provides good self-cleansing action by rain with no recess areas to harbor insects
- Resistant to breakage
- Stable characteristics throughout useful life.

For insulation purposes the electric fence external to the controller must be considered similar to other electric lines carrying more than 600 volts. This is to prevent leakage currents, and not because of safety hazards. This includes lead wires, lightning arresters and cables under roads. Ordinary rubber-covered wire as used in farm wiring is not suitable for leads unless used with insulators of the improved type recommended for bare wires. Rubber milking machine hose is extremely poor as insulation.

Summary

The engineering problems associated with the use of electric fences are: (a) determination of the electrical characteristics of an effective shock as related to the energy limitations required for safety; (b) equipment for producing such an effective shock; and (c) conveyance of the effective shock to livestock, with minimum energy loss. This paper concerns the latter problem. The control of livestock in strip grazing requires a more exacting performance of the electric fence and thus provides an excellent means of evaluating electric fence systems. A portable post with quick wire attachment has been developed to simplify moving of the fence. Use of polyethylene insulation in portable fences resulted in improved performance as compared to conventional porcelain.

Additional tests of polyethylene insulators indicated ten times greater surface resistance than conventional porcelain insulators under comparable conditions. Measurements indicate a need for improved fence insulators which will maintain high surface resistance under all weather conditions and be resistant to breakage. Four types of insulators are needed: for strain points, for gates, for permanent fences, and for portable fences. Additional information is needed concerning the durability of polyethylene and other materials of high surface resistance which might be used in commercial production.

In addition there is a need to determine the effect of improved fence insulators on the electrical output requirements on fence controllers to obtain safe yet effective shock; also the possible importance of capacitance effects as leakage is decreased should be investigated.

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The Self-Propelled Combine

(Continued from page 183)

controls the flow of oil to and from the leveling cylinders. To speed up the hydrostatic action, a servopiston is placed in the reservoir and actuated by one of the swing arms. The Northwest has nicknamed this piston the "gravity booster".

This rather simple arrangement has very satisfactorily provided automatic leveling control of the combine.

For safety reasons automatic check valves are installed on each leveling cylinder to guard against the machine tipping in case of hydraulic-line or hose failure.

The steering assembly interchanges with the regular steering unit of the level-land machine. The wheels are mounted on a parallelogram arrangement so that they remain vertical for best steering and easiest control. The power-steering installation is a conventional automotive hydraulic unit with drag-link valve, and a booster cylinder receiving its power from a small pump mounted dual with the master hydraulic-power pump.

Although weight distribution is critical in hillside work, it presented no serious problem. The only change in longitudinal center of gravity placement was to lengthen the wheelbase slightly by moving the drive wheels ahead of their level-land position.

The tire equipment is important for good performance. A low-profile tread is a necessity. A cleat on the tire of a self-propelled hillside combine is useless.

In addition to being smooth, hillside tires must be large. On the steep hills the soil is usually loose. To secure footing the tire must reach out and cover the maximum area because the soil shear value is low. Extra wide rims are used on the drive tires. When 18-26 tires are used the rim is 20 in wide. With 15-26 tires a 16-in rim is used. On the Model 55H combine the 18-26 tire is proving to be the more popular because of its better all-around performance.

A 9-16 smooth-tread tractor tire was found to give the best steering response under all conditions. This tire has the same low-profile tread used on the drive tires. The use of this tire resulted from a hunch by one of our experimental men who included a set of these tires with the experimental machines, purely on his feeling that they might work. They did. The 9-16 steering tires are mounted on 8-in rims.

Old or new, however you care to look at it, the self-propelled hillside combine is one of the most interesting engineering developments in the agricultural machinery field.

Red Iron Oxide Barn Paint

D. F. Laughnan

This paper reports progress on an extensive research project undertaken for the purpose of developing information that will lead to the formulation of red iron oxide paints of superior durability for farm buildings

PAINTS applied to the exterior of farm buildings other than the residence should be more durable than house paints if they are to give satisfactory service. This is because most farm buildings receive no more than two coats of paint at the time of construction, and it is common practice to allow 10 years or more to elapse between repaint jobs. Moreover, farm buildings are generally sided with one of the dense softwoods that require the best paints and painting methods for good results.

It has been customary for many years to paint farm buildings with red iron oxide barn paints. This practice is still widespread, although red iron oxide barn paint has been giving way to some extent in recent years to white and light-colored paints. This, in the opinion of the USDA Forest Products Laboratory, is unfortunate because it is generally accepted that the dark-colored paints are more durable than white or light-colored paints; hence the dark-colored paints are more likely to meet the hard service required of barn paints than are the white and light-colored paints. On the other hand, many red iron oxide barn paints on the market have not given satisfactory service.

A study of red iron oxide barn paints available commercially revealed that such paints, with few exceptions, are enamellike rather than paintlike in their characteristics. They are made so by incorporating large proportions of bodied drying oils or varnishes in the vehicle. Heat treatment of drying oils results in high viscosity, which as a rule must be offset by adding large proportions of volatile thinner. Frequently the amount of pigment dispersed in a vehicle of this type must also be reduced in order to obtain a brushable product.

Red barn paints of this kind are relatively fast-drying; they dry to a high gloss finish, and most of them are mildew resistant and remain reasonably clean in service. However, because of their flow characteristics, they must be applied in thin coatings to avoid runs, sags, and beads. Because they flow out to form a smooth, glossy film free of brush marks, they accentuate irregularities in the surface on which they are applied, such as raised grain, knots, and flaked patches of the previous paint. Some of these properties undoubtedly have been provided in barn paints as the result of buyer demand, but the Forest Products Laboratory has long questioned the adaptability of the enamellike type of barn paint to the conditions under which it must serve.

In 1948 the Laboratory undertook extensive research on red iron oxide barn paints with the objective of developing information that will make it possible to formulate red iron oxide paints of superior durability. The research consists of several parts or series, each designed to furnish answers to different questions relating to the formulation and composition of such paints. Altogether, 260 paints are included in the study, 20 of them commercial paints and the remainder formulated and made by the Laboratory. These paints have been applied on 385 test areas.

All paints were applied by brush on drop-siding panels approximately 21 by 70½ in in size. Each panel is made of two courses of southern yellow pine and two of Douglas fir and is divided into four test areas 2.69 sq ft in size. Because of the magnitude of the study, the panels were erected on test fences over a three-year period, 1949 through 1951. Naturally developments in most phases of the study have not yet progressed sufficiently to afford conclusive information. This may require four to five years of additional exposure. This discussion is therefore limited to some of the useful information thus far developed from the study.

One of the first studies to be undertaken was that of film thickness, the purpose of which was to determine the optimum film thickness for red iron oxide barn paints. Three distinctly different types of red barn paints were formulated for inclusion in this study. One was made with medium ferric oxide content and high total pigment, in a vehicle of body *Q* linseed oil fortified with a short-oil ester gum varnish. Another was made with high ferric oxide content and high total pigment content, in a vehicle that is predominantly raw linseed oil fortified with a slight amount of heavy-bodied linseed oil (body Z6). The third paint was made with extremely low ferric oxide content and a low total non-volatile content, the vehicle being two-thirds heavy-bodied linseed oil and one-third raw linseed oil. On the basis of their brushing characteristics, one of the paints was enamellike, another paintlike, and the third intermediate. Two of the three are representative of barn paints available on the market.

The Forest Products Laboratory has long applied paints on exposure panels under controlled spreading rates to provide a given dry film thickness. In this study, the three paints were applied to provide dry film thicknesses of 0.001, 0.002, 0.003, 0.004, and 0.005 in. After the paints were applied and had dried, small sections of each of the paint films were removed with a special instrument resembling a cork borer, designed for the purpose, and their thickness measured under the microscope.

After 12 months exposure, the thinner films (0.001 and 0.002 in thick) of all three paints showed some failure of the cracking, curling, and flaking type. After two years, the films 0.003 in thick had likewise begun to crack, curl, and flake. Now, after five years of exposure, only the films 0.005 in thick show good durability. It should be added that these films also show the greatest dirt retention; the thinner films seemingly wear or erode away at a faster rate, so that they remain cleaner.

These observations lead to the conclusion that the optimum film thickness for red iron oxide barn paints is about 0.005

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Farm Structures Division.

The author—D. F. LAUGHNAN—is technologist, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, Madison, Wisconsin.

in, the same as that for white and light-colored house paints (1).* Unfortunately it is impossible to attain film thickness of this order with only two coats of the enamel-like red iron oxide barn paints generally available on the market. In a later phase of the study, in which two coats of each of 20 commercial barn paints were applied to exposure panels, the calculated film thickness of most of the paints (applied in accordance with the directions on the labels) was 0.0020 to 0.0025 in. With a few of the paints, a dry film thickness of 0.0035 in was obtained, but with none was this thickness exceeded.

The Forest Products Laboratory found in the work it did on two-coat house paint systems that such paints, to provide adequate film thickness in two coats, must be made with high non-volatile content. The same principles undoubtedly apply to red iron oxide paints. This means that the amount of heat-treated component (bodied drying oil or varnish) must be held to a minimum and the major portion of the non-volatile vehicle must be raw linseed oil. Paint thinner must likewise be held to a minimum. Paints made in this way are more paint-like in their characteristics. Most of them dry with brush marks and all result in the deposit of more dry film per coat on the wood than do the enamellike paints.

The Forest Products Laboratory had considerable experience with red iron oxide barn paints made with a straight raw linseed oil vehicle prior to 1948, when this study was undertaken. It was demonstrated repeatedly by test that such paints possess durability superior to that of the enamellike paints, but they also have some disadvantages. They dry slowly and may not dry with a uniform gloss. They are likely to be vulnerable to dirt collection and to attack by mildew. Such paints invariably dry with a low gloss, but the Forest Products Laboratory does not consider this a disadvantage. In fact, there is some preference for such paints over high-gloss paints on the lower grades of wood commonly used on farm buildings, because they do not mirror or accentuate the irregularities in the surface of the wood as do the high-gloss paints.

Excessive dirt collection and vulnerability to mildew, however, are serious disadvantages that must be eliminated. In an effort to overcome these disadvantages, two individual phases of research were undertaken. One involved the substitution of chemically active pigments for varying proportions of the ferric oxide; the other, substitution of heat or chemically treated oils or varnishes for a portion of the raw linseed oil in the vehicle.

The chemically active pigments included in this work are chrome orange, chrome yellow, zinc oxide, basic carbonate white lead, and basic silicate white lead. Each of these was substituted to the extent of 10, 20, and 30 percent of the volume of the iron oxide pigment in a control paint made with high pigment content, high ratio of ferric oxide to transparent pigment, and high total non-volatile content. All of the paints in this portion of the study were made with a straight raw linseed oil vehicle.

The zinc oxide (a highly reactive type) has been the most effective of the five pigments in protecting against dirt collection and mildew attack. However, the concentration of zinc oxide must be limited if premature cracking and curling are to be avoided. Only the paint made with the lowest level of zinc oxide (10 percent of the volume of the ferric oxide pigment) shows durability superior to that of the control paint.

All of the chemically active pigments at one concentration or another demonstrated durability improved over that of the control paint. The best concentration with zinc oxide and basic carbonate white lead was 10 percent, with chrome yellow, 20 percent, and with chrome orange and basic lead silicate, 30 percent. However, in such concentrations both the chrome orange and the chrome yellow alter the color of the red iron oxide barn paint objectionably. Basic carbonate white lead, basic silicate white lead, and zinc oxide markedly reduce the dirt collection of the paints, with zinc oxide best in this respect.

In the portion of the study devoted to fortification of the vehicle, seven fortifying agents (oils, resins, or varnishes) were added to the extent of 15 percent of the volume of the vehicle. These include a body Z3 linseed oil, a chemically treated whole soybean oil, a 5-gal ester gum varnish, a hydrogenated methyl ester of rosin, a linseed-tung-oil mixture, a gloss oil, and linseed oil neutralized with calcium oxide. The panels for this phase of the research were exposed in June, 1951. Each of the fortifying agents was used in five basically different paints made with a ferric oxide pigment manufactured by a different process.

In general, the fortifying agents or additives improve the cleanliness and uniformity of the paints. More important, some of the additives enhance the durability of the paints. Best of these are the calcium oxide-neutralized linseed oil, the chemically treated whole soybean oil, and the body Z3 linseed oil. Cleanest of the paints in all the series are those fortified with the gloss oil and the ester gum varnish. The ester gum varnish detracted slightly from the durability; the gloss oil and the hydrogenated methyl ester of rosin detract materially from the durability. Developments have not yet progressed sufficiently to permit final conclusions to be drawn.

In still another phase of this research, paints were made in which ferric oxide content ranges from 20 to 80 percent of the total pigment, in steps of 10 percent. Two control paints, both made with high total pigment and high non-volatile content, were selected for this study, one made with Spanish oxide No. 500 and the other with a synthetic iron oxide pigment. Results to date indicate that there is a reasonably wide latitude permissible with respect to ferric oxide content. All properties considered, a ferric oxide content of 30 to 50 percent of the total pigment appears at this time to be optimum.

In conclusion, this paper must be considered only as a progress report. Many of the paints of this study have been on exposure only 4½ years. While this is sufficient exposure to demonstrate the disadvantages of the weaker paints, it is not sufficient to develop differences between the paints of higher quality. The study has shown, though that red iron oxide barn paints must be applied in adequate thickness to give satisfactory service. To accomplish this, paint-like rather than enamellike consistency is needed. It has also revealed that careful fortification with chemically active pigments or bodied ingredients is desirable.

*Numbers in parentheses refer to the appended references.

Reference

Browne, F. L. The two-coat system of house painting. *Industrial and Engineering Chemistry*, chapter 33, p. 900 (1941); revised (1950).

NEWS SECTION

Lubrication Engineers Meet

THE 11th annual meeting and exhibit of the American Society of Lubrication Engineers will be held at the William Penn Hotel, Pittsburgh, Pa., April 4, 5 and 6. A panel session, 48 technical papers, and a concurrent lubrication engineering course will comprise the 22 technical sessions.

Non-members are invited to register and participate in the scientific and educational sessions of the meeting. Complete program and registration information can be obtained from the administrative secretary, American Society of Lubrication Engineers, 84 E. Randolph St., Chicago 1, Ill.

Concrete Draintile Meeting

TWO important research discoveries were revealed at the first annual Midwest concrete draintile manufacturers meeting held at Purdue University on January 26 and 27.

Fred W. Blaisdell, USDA Agricultural Research Service, St. Anthony Falls hydraulic laboratory, Minneapolis, Minn., showed evidence to those in attendance that there is no essential hydraulic difference between lines with laterals tied to mains at right angles and lines with laterals brought in at angles of from 15 to 75 degrees as formerly believed.

Dalton G. Miller, consulting drainage engineer, showed two pieces of draintile both meeting all ASTM test requirements including strength and absorption. These tile were then subjected to an internal water-pressure test not called for in the specifications. One tile held 100 psi pressure several minutes without any signs of leakage. The other leaked exceedingly at a pressure of only 5 psi.

Several other papers were presented to the meeting jointly sponsored by the American Concrete Agricultural Pipe Association and the agricultural extension service of Purdue University. The audience was made up of concrete draintile manufacturers, tile machinery manufacturers, agricultural engineers from various federal agencies, and university and extension representatives from six states.

Several agricultural engineers participated in the program. George E. Spencer, head, agricultural engineering department, Purdue University, welcomed the group. Henry N. Luebcke, Soil Conservation Service, USDA discussed the interrelationship between highway and agricultural drainage. Keith W. Beauchamp, irrigation engineer, Soil Conservation Service, USDA, spoke on the ASAE specifications for the design and construction of tile drains in humid areas, and John G. Sutton, drainage engineer, Soil Conservation Service, USDA, discussed progress in obtaining durable concrete tile drainage systems. The tile testing programs in various states were discussed by Dalton G. Miller; Philip W. Manson, University of Minnesota; Willard A. Cutler, Michigan State University, and Ben F. Muirheid, University of Illinois. Homer Neisz, farm field representative, Portland Cement Association, was co-author of a paper, entitled "There's No Substitute for Quality." This paper dealt with the basic requirements for gradation and ample water to hydrate the tile mix. Of three tile mixes demonstrated, the one with a fineness modulus of about 3.7 was considered most ideal.

D. G. Miller told of the extensive tests which have been conducted by him and P. W. Manson over a period of more than 20 years on the effect of acids on various concrete mixes. The meeting was entertained by an informative talk on Korea by Mr. Manson who returned from that country a few weeks ago.

ASAE Meetings Calendar

March 30 and 31—ROCKY MOUNTAIN SECTION, New Mexico College of A. & M. Arts, State College.

April 6 and 7 — MID-CENTRAL SECTION, Robidoux Hotel, St. Joseph, Mo.

April 20 — MICHIGAN SECTION, Dearborn, Michigan

June 17-20—49TH ANNUAL MEETING, Hotel Roanoke, Roanoke, Va.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

National Farm Wiring Conference Planned

THE first national farm wiring conference will be held at the LaSalle Hotel, Chicago, on May 3 and 4. The conference is the first of its kind to be sponsored by the National Electrical Manufacturers Association in cooperation with its farm wiring subcommittee. It will bring together qualified experts from industry, national farm organizations, the USDA Extension Service and educational institutions to discuss the problems involved in farm wiring. It is expected that a program on how to inform, promote and sell adequate wiring to farm people will be proposed or provisions will be made for forming a committee to develop such a program. Details may be obtained from the NEMA office at 115 E. 44th St., New York 17, N.Y.

FEI Industry-Research Conference at Cornell

THE 13th industry-research conference, in which the Farm Equipment Institute agricultural research committee is a cosponsor, will be held at Cornell University, Ithaca, N. Y., March 28 and 29, under the auspices of the agricultural engineering department.

During the first day papers will cover such topics as experiment station research, impact of mechanization on New York farmers, equipment needs of farmers, engineering education at Cornell, irrigation research in New York, tillage research in the Northeast, a plow-plant system for corn, and experimental design for plow-plant equipment.

The second-day program will include papers on pesticide application and evaluation, development of pesticide application equipment, utilization of experiment station research by industry, trends and problems in distributing bulk feeds, hay and silage storage and feeding experiments, utilization of forage drying in New York, industry's approach to mechanized forage handling, and a panel on forage production and handling research.

Programs may be obtained by writing the FEI general offices, 608 S. Dearborn, Chicago 5, Ill.

Agricultural Engineers at Concrete Draintile Meeting

Many members of the American Society of Agricultural Engineers were on hand at the Midwest Concrete Draintile Manufacturers meeting held at Purdue University, January 26 and 27. *(Left)* From left to right, H. F.. Peckworth, American Concrete Agricultural Pipe Association, Chicago; H. N. Luebcke, SCS, Wapakoneta, Ohio; H. B. Neisz, Portland Cement Association, Indianapolis, Ind.; Dalton G. Miller, consulting engineer, St. Paul, Minn.; G. E. Spencer, head, agricultural engineering, Purdue University; W. A. Cutler, extension agricultural engineer, Michigan State University. • *(Right)* From left to right, D. R. Sisson, extension agricultural engineer, Purdue University; K. H. Beauchamp, SCS, Milwaukee, Wis.; John G. Sutton, SCS, Washington, D.C.; F. W. Blaisdell, Agricultural Research Service, Minneapolis, Minn.; H. N. Luebcke, SCS, Wapakoneta, Ohio; and John R. Davis, professor, agricultural engineering, Purdue University

Roanoke, Virginia, Scene of the ASAE 49th Annual Meeting, June 17 to 20

Natural Bridge of Virginia

Roanoke is located midway in distance between New York and Atlanta. It lies in the great Valley of Virginia between the Blue Ridge and Allegheny Mountains. It is called "Star City of the South". It got this name from a giant 100-ft star located on top of Mill Mountain (elevation 2,000 ft). The star is lighted by 2,000 ft of neon tubing and can be seen from a distance of many miles. Roanoke has a population of 141,000, two colleges, 31 public schools, 195 churches, 24 parks, six hospitals, 285 industries, four radio stations and two television stations.

Trip to Natural Bridge Planned

A BUS tour to Natural Bridge of Virginia is being planned for members and friends of the American Society of Agricultural Engineers during the 1956 ASAE Annual Meeting to be held June 17 to 20 at Roanoke, Va.

Natural Bridge is one of the Seven Natural Wonders of the World. The Indians worshipped it, Thomas Jefferson owned it, and George Washington surveyed it. It is magnificently arched, extending 215 ft high and 90 ft long. The archway is formed from 36,000 tons of limestone overlooking a simple mountain stream. A blending of earth colors of dull red, ochre, yellow and rich cream lends to its enduring beauty. The hours of the day and the seasons of the year provide an everchanging setting endowing it with infinite variety. Each night throughout the year, colored lights stream over its towering walls adding deeper significance to its greatness as a tourist attraction. Henry Clay, the great American statesman, once described it thus: "The bridge not made by hands, God's great stone masterpiece, spans a creek, carries a national highway and makes two mountains one."

Natural Bridge is closely associated with the traditions, history and romance of America. In 1774, Thomas Jefferson bought the bridge and 157 surrounding acres from King George III of England for the sum of "twenty shillings of good and lawful money". In 1802 he surveyed his purchase and made with his own hands the first map of the bridge and its surroundings. A year later he had a log cabin built, one room of which was kept for such visitors as Henry Clay, John Marshall and James Monroe. Jefferson predicted: "Natural Bridge will yet be a famous place that will draw the attention of the world". This prophecy is fulfilled each year. George Washington surveyed the bridge about 1750. His initials "G.W." are carved on the bridge, 23 ft above Cedar Creek, and appear again with his surveyor's cross on a large stone still located under the arch. The stone served as his benchmark. During the Revolutionary War, for the lack of a shot tower, molten lead was dropped from the top of the bridge into the creek, to make bullets for the colonists.

Electric Motor Conference

THE National Electrical Manufacturers Assn. has scheduled a motors-in-agriculture conference to be held at 2:00 p.m., March 14, at the Edgewater Beach Hotel, Chicago, Ill. The meeting is planned to bring major manufacturers of electric motors and leading representatives of the farm electric equipment industry together to analyze and discuss problems involved in putting electricity to work more effectively in agriculture.

A symposium of key farm electric industry executives, a talk by an extension service leader and a showing of a new farm film by the University of Wisconsin will appear on the program. The meeting will be held in connection with the annual midwinter conference of the National Electrical Manufacturers Association.

Two other NEMA conference events are scheduled for March 13. Starting at 9:30 a.m., a symposium will be held on problems involved in government purchases of electrical equipment. It will be followed by a presentation of the "Live Better Electrically" project. This program has been planned to stimulate the increased purchase of household electrical equipment and to stress the importance of adequate wiring.

Farm Equipment Shipments Up

A RELEASE issued January 18 by the Business and Defense Services Administration, U.S. Department of Commerce, reported that shipments of farm machinery and equipment to dealers during the industry fiscal year which ended Oct. 31, 1955, exceeded the total for the preceding comparable period by approximately 15 percent.

It is reported also that according to voluntary reports from the principal producers, received by the Agricultural, Construction, Mining and Oil Field Equipment Division of the Business and Defense Services Administration, the volume of farm machinery and equipment shipped to dealers for domestic use increased slightly over 18 percent, but exports normally representing about one-seventh of the total shipments declined approximately 6 percent.

The year's increase in sales to dealers reversed a decline that had been in progress over the past three years, it is said. Tractor shipments which generally account for about one-third of the industry's total volume of sales to dealers, increased substantially during the fiscal year. In that period, approximately 335,000 tractors were shipped by manufacturers to dealers.

Shipments of farm machinery and equipment to dealers, other than wheel tractors, are reported to have declined only slightly over the past five years, and showed a slight increase in 1955 over the preceding year. The same pattern shown in tractor sales was evident in the other machinery and equipment, domestic sales being up and export sales down.

Mason Vaugh Elected to Life Membership

THE Council of ASAE recently conferred the grade of Life Member upon Mason Vaugh, who for the past 35 years has been associated with mission work in India, and with the active management and development of the Allahabad Agricultural Institute.

Mr. Vaugh earned a B.S. degree in agriculture and one in agricultural engineering from the University of Missouri. His first employment after graduation was with the Allahabad Agricultural Institute where he organized the first degree course in agricultural engineering in India. For many years he served as head of the department. Since his retirement a few years ago, he has spent full time in operating and developing an implement factory for the production of small plows especially suited to Indian agriculture. A recent letter from Mr. Vaugh reports that a riding disk cultivator to work astride the rows, a bullock-powered low-lift pump, and a new disk harrow for animal power have been developed. Work is in progress on a simple type of seed drill of five spouts, built on a cultivator for furrow openings.

Throughout India, Mr. Vaugh is famous for his professional work in agricultural engineering. He has done an outstanding job in improving the standard of living in that country.

NEWS OF ASAE MEMBERS

W. J. Ridout, Jr., editor of *Electricity On the Farm* magazine for the past five years, has been appointed editorial director of the publication, and **Hugh J. Hansen**, formerly associate editor, has been advanced to editor.

Mr. Ridout is an agricultural engineering graduate from Virginia Polytechnic Institute and has been associated with Kentucky Power Co., East Tennessee Light and Power Co., Clemson College as extension agricultural engineer in charge of farm electrification, extension service at North Carolina State College, and Edison Electric Institute. He is past-chairman of the ASAE Rural Electric Division.

Mr. Hansen received a B.S. degree from North Dakota Agricultural College and an M.S. degree in agricultural engineering from Cornell University. He was assistant professor of agricultural engineering at Purdue University, and has worked for International Harvester Co., Nodak and Tri-County Electric Cooperatives, and U.S. Department of Agriculture in farm electrification research.

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Jack T. Musick, former graduate assistant, Oklahoma A. & M. College, has accepted a position as agricultural engineer, Irrigation Experiment Station, Prosser, Wash.

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Robert B. Hurley has joined the Southern Irrigation Co., Memphis, Tenn., as a sales engineer. Formerly he was work unit engineer with U.S. Soil Conservation Service in Hondo, Texas.

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Robert W. Louden has announced that the Robert W. Louden Co., has purchased rights to the Rateonics Corporation's utility cost auditing, analyzing and consulting services for Iowa and the Quad Cities. Rateonics Corp., Dallas, Tex., has audited utilities costs for over 15,000 business firms. Mr. Louden will continue to have his headquarters in Fairfield, Iowa. Rights to the five territories established in his area are being assigned. The territories are Des Moines, the Quad Cities, and northeastern, western and southeastern Iowa.

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August Schulbach, Jr., is now located in the Blue Nile Province of Sudan, Africa. He is an agricultural engineer for the Sudan Ministry of Agriculture. He reports that he met **Charles R. Brandt** from Iowa, who also works as an agricultural engineer for the Sudan.

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John C. Steele, assistant extension agricultural engineer, University of Nebraska, has accepted an exchange professorship at the University of Ankara in Turkey. His assignment is to work with the University in setting up a course of study in irrigation and drainage. He plans also to assist them in initiating a program of research in this field.

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Franklin E. Fisher has completed a tour of duty with the USAF and is now employed by the Tractor and Implement Division, Ford Motor Co., in the product design engineering section.

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Willard F. Rissmiller, former sales and promotion engineer, Aldrich Co., has accepted a position with the research department of the Caterpillar Tractor Company, Peoria, Ill.

Wiley D. Poole, agricultural engineer, Louisiana Agricultural Experiment Station, has received the Louisiana Engineering Society's technological accomplishment medal for his contributions to the mechanization of the sweet potato industry. Mr. Poole developed a tractor-mounted harvester that excavates, cleans, and loads sweet potatoes, sugar beets and similar root crops with the speed of 30 workers. The machine was unveiled a year ago after four years of research. It has been hailed by agricultural experts as years ahead in the field of sweet potato harvesting.

W. D. POOLE

The award was established in 1950 "for distinguished service in the field of technological advancement or discoveries as contributing to the advancement of engineering." An important purpose of the honor is "to encourage and inspire the recipient to reach ever greater heights of professional achievement."

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A. W. Cooper will receive the degree of doctor of philosophy from Michigan State University with a major in agricultural engineering and a minor in physics on March 15. After that date he will be connected with the Tillage Machinery Laboratory (AERB, ARS), U.S. Department of Agriculture, Auburn, Ala.

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Joseph W. Karban has received a transfer and promotion to hydraulic engineer with the Central Technical Unit of the Soil Conservation Service, USDA, Beltsville, Md. Formerly he was with the small watershed planning party (SCS) at Waukomis, Oklahoma.

With the ASAE Sections

Rocky Mountain Section

The Rocky Mountain Section will meet at Milton Hall, New Mexico A. & M. College, State College, March 30 and 31. A full day program is planned for Friday and a morning session on Saturday.

J. E. Christiansen, dean of engineering, Utah State Agricultural College, will preside during the first morning session. After a welcoming address by Dr. R. B. Corbett, president of New Mexico A. & M. College, H. S. Pringle, extension rural electrification specialist, USDA, will speak on electricity on the farm, present and future. Other speakers on the morning program will include Lawrence Gardenhire, White Sands Proving Ground, who will speak on solar heating; John G. Felton, Sylvania Electric Products Co., who will discuss farmstead lighting; and Allan S. Humpherys, Utah State Agricultural College, who will speak about vibratory compaction of stabilized earth material employed for canal lining. G. D. Williamson, E. C. Fortier, and L. Kristoff, No-Joint Concrete Pipe Co., will describe continuous no-joint concrete pipe construction.

The afternoon program will include papers on Upper Colorado River problems by John H. Bliss, Upper Colorado River commissioner; and watershed yield by R. B. Hickok, project supervisor, USDA, Albuquerque, N. M. W. M. Miller, University of Wyoming, will preside. A student papers contest for students from Colorado A. & M. College, Utah State Agricultural College, New Mexico A. & M. College and the University of Wyoming, will be conducted by Norman A. Evans, Colorado A. & M. College. A business meeting will follow.

Wives and guests are invited to attend the Friday evening, dinner meeting. Wayne H. Worthington, president of ASAE, will be the dinner speaker.

J. W. Borden, Eversman Mfg. Co., will preside at the Saturday morning session. Norman A. Evans, Colorado A. & M. College, will describe geophysical methods in drainage investigation; D. F. Peterson, Colorado A. & M. College will speak on well hydraulics; W. E. Code, Colorado A. & M. College will explain ground water legislation and associated problems; and H. P. Smith, Texas A. & M. College, will speak on cotton mechanization and production. Victor Stedronsky, engineer in charge, Cotton Ginning Laboratory at Mesilla Park, N. M., will conduct a cotton ginning demonstration.

Southeast Section

G. W. Giles, head, agricultural engineering, North Carolina State College, was elected to chairman of the Southeast Section at a meeting held at Atlanta, Ga., February 6 to 8. Other new officers were R. P. Kay, field representative, Douglas Fir Plywood Assn., 1st vice-chairman; J. M. Myers, associate engineer, Florida Agricultural Experiment Station, second vice-chairman; and Tom E. Corley, associate agricultural engineer, Alabama Polytechnic Institute, new secretary-treasurer. Mr. Giles succeeds R. F. Colwick, who served as chairman during the past year.

Georgia Section

A meeting and fishing trip are being planned by the Georgia Section for sometime in May. A ballot has been mailed to section members to determine the most convenient date. Panama City, Fla., has been suggested as the most likely port. Wives have been asked to join the men on the fishing trip this year.

Mid-Central Section

Plans are being made for a meeting of the Mid-Central Section for April 6 and 7 at the Robidoux Hotel, St. Joseph, Mo. Section Chairman L. W. Hurlbut, has promised a fine program. Tentative plans call for a brief tour on Friday afternoon, bowling competition in late afternoon, a dinner and discussion in the evening, and a program of papers on Saturday morning. The meeting will conclude with a noon luncheon.

Michigan Section

The Michigan Section will meet April 20 in a yet to be designated site in Dearborn. The theme topic for this meeting is entitled "Management Engineering, A New Field in Agriculture." Harold E. Pinches, assistant director of farm and land management research, USDA, and James Apple, engineering department, Michigan State University, will head the discussion. A tour of the Ford Motor Co. research center is planned. Irving A. Duffy, vice-president and general manager of the Tractor and Implement Division, Ford Motor Co., will give the banquet address. Wayne H. Worthington will attend the meeting and speak at the dinner.

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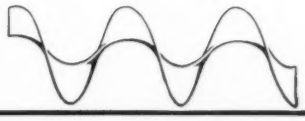
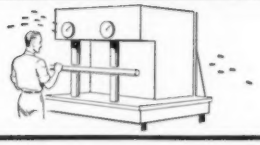
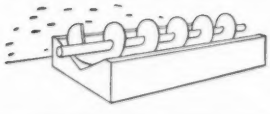
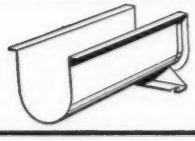
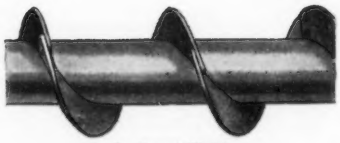
ONE-PIECE HELICOID FLIGHTING		Continuous flighting has greater smoothness and strength. Link-Belt also builds many different types to meet your special needs—cut flight, short pitch, ribbon flight, tapered flight, double flight to name a few.
UNIFORM PITCH		Consistent, accurately-formed flighting is produced by specialized modern machinery.
STEELS THAT MEET OUR SPECIFICATIONS		Selected steel for flighting, assures a uniform, smooth, accurately rolled product.
STRAIGHTNESS		Straightness of the completed auger is checked before shipping. Extra care is taken in handling and loading.
ALL COMPONENTS		A full line of related equipment can be supplied by Link-Belt specially engineered for your requirements. This includes troughs, spouts, hangers, drives.

Typical examples of LINK-BELT AUGERS



Sectional-flight

Helicoid flight with plain beater

Helicoid flight

Unmounted Helicoid flighting

Opposed flights with center saw-tooth beater

These are only a few of the many important performance extras you get with Link-Belt augers. Ask your nearest Link-Belt office for 92-page Data Book 2289.

LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,800

NEW PRODUCTS CATALOGS

Pull-Type Rotary Cutter

Deere and Co., Moline, Ill., has announced a new pull-type, 5-ft rotary cutter designed to fit any tractor which has a standard drawbar and power take-off.

The 15-in automobile-type carrier wheels can be placed in the forward position at 80-in tread, or in the trailing position at

52, 57, 75, or 80-in tread. Leveling of the frame is done with a large hand wheel. Cutting height (0 to 14 in) is controlled with either a remote hydraulic cylinder or a manual screw jack.

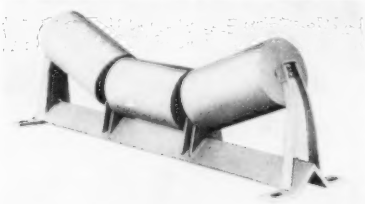
The new cutter has a single rotor arm with a flail-type, alloy-steel blade at each end. Three types of blades are available—straight, for general-purpose use and heavy brush cutting; suction, for lifting light grass and weeds into the path of the blades; and pickup, for clawing up roots and downed stalks. A shredding attachment which triples the number of cutting edges also can be installed. When fine shredding is not required, the rear grille can be raised to facilitate spreading of cut material.

Power is transmitted to the blades through bevel gears, protected by a friction-type slip clutch. The machine-cut alloy-teel gears run in oil in a malleable gearbox. Weight of the pull-type model is about 1,350 lb.

New Design Conveyor Idler

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has introduced its new series 50 ball-bearing, belt-conveyor idler. The new idlers are available in both a greaseable type, with a "one shot" lubrication system serving all three rolls at once, and a factory-sealed type, which requires no further greasing.

Basically, the idler rolls consist of a smooth, uniformly thick outer shell plus a heavy-wall steel center tube. These tubes



are brazed to dish-shaped steel heads, forming a moisture-tight, integral unit. The structural steel dished heads are press-fitted into a counterbore in the shell over a journal on the center tube. The bearings are positioned close to the shaft supports to reduce overhang. All brackets are locked together to form a rigid-truss structure. The steel brackets and foot straps are welded to an inverted angle base.

The series 50-belt-conveyor idlers are available for seven belt widths from 14 to 36 in. Information on the complete line is contained in folder 2516, available on request to Link-Belt Co., Dept. PR.

Irrigation Water Strainers

Rife Hydraulic Engine Mfg. Co., 30 Church St., New York 7, N. Y., has announced a new galvanized irrigation strainer, constructed of heavy-duty, all-

welded steel. It is galvanized by a hot-dip process after fabrication. The screen perforations are punched from a metal sheet. Top and bottom flanges hold the screen away from stream sides and bottom in every position. The open screen has five times the pipe area for high suction.

Strainers are available in 3, 4, 5, 6 and 8-in pipe sizes; respective outside diameters are 10, 11, 12, 14 and 17 in. Weights range from 8 to 31 lb.

New 125-Bu Manure Spreader

New Idea Farm Equipment Co., Coldwater, Ohio, has introduced its new No. 19 125-bu manure spreader. The new model succeeds the No. 15 and features concentration of the entire major-drive mechanism (clutch, beveled drive gears and cam) inside an oil-filled, dirt-free housing. The

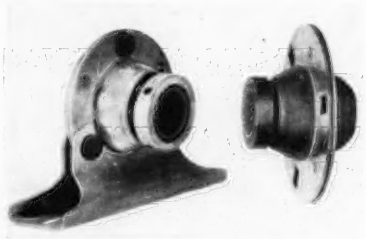
four-jawed, spring-loaded, throwout clutch permits the conveyor to operate independently. Protecting the spreader mechanism is a torque-limiting, disk-type, overload slip clutch mounted on the drive shaft. The yellow pine box is supported by a husky steel frame and full-length steel flares. The wood is treated with water-repellent penta preservative and sprayed with paint for long rot-free life. A slanted arch is said to permit unloading bigger loads without plugging. It is out of the way of the hydraulic loader and deflects manure to the paddles for even spreading and fine shredding. Paddles are mounted in pairs, individually removable.

The new model is available with 9.00-24 grooved implement tires, or 20-in disk wheels with removable rings for mounting used truck tires. Five feed ranges for each forward speed of the tractor give the operator close control of spreading.

Self-Aligning Bearing

The Cleveland Graphite Bronze Co. Division of Clevite Corp., 17000 St. Clair Ave., Cleveland 10, Ohio, has developed a new self-aligning bearing for farm equipment and other machinery.

Features of the new unit include: self-alignment even during operation of varia-



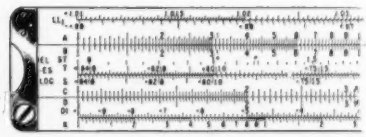
tions up to ½ in per foot of distance between bearing centers; nylon corrosion insulator; dirt-free operation in which the felt seal conforming to the bearing's spherical surface is not compressed or expanded as alignment is adjusted; and built-in reservoir providing lifetime lubrication.

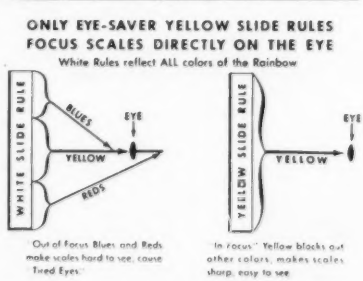
The new bearing was designed initially for farm equipment and can be used in a great variety of equipment, such as construction machinery, blower fans and conveyors. The light-weight unit comes completely assembled in two basic sizes covering a broad range of shaft diameters from ¾ to 1⅜ in. Where installation space is limited, the flange diameter can be reduced. It can be pillow-block mounted and will handle both thrust and radial loads with no thrust collar necessary on the shaft.

An illustrated brochure, with full specifications on sizes, dimensions and load capacities, is available by writing the manufacturer.

New Slide Rule Saves Eyes

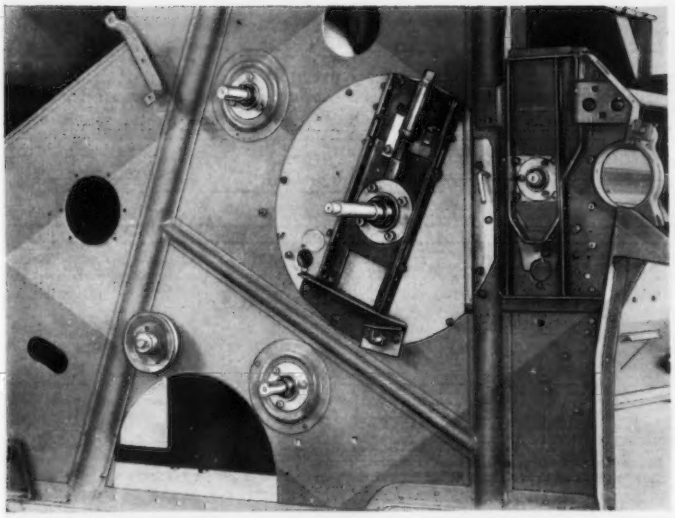
A light-alloy slide rule made in green-yellow eliminates violet and red rays which focus in front of and behind the retina. The green-yellow shade coincides with the optimum sight point of the spectrum, thereby cutting eye strain, blurring and errors in




ONLY EYE-SAVER YELLOW SLIDE RULES FOCUS SCALES DIRECTLY ON THE EYE
White Rules reflect ALL colors of the Rainbow
WHITE SLIDE RULE
BLUES
YELLOW
REDS
EYE
"Out of Focus" Blues and Reds make scales hard to see, cause Tired Eyes.
YELLOW SLIDE RULE
YELLOW
EYE
"In Focus" Yellow blocks out other colors, makes scales sharp, easy to see.

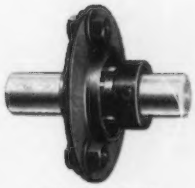
reading calibrations. The rule is of non-corrosive, non-rusting metal construction which eliminates warping, swelling and binding. It is now made in 6-inch and 10-in trig, log-log standard rules, or in rules made to special order. Free catalog will be mailed on request to Pickett & Eckel, Inc., 1109 S. Fremont Ave., Alhambra, Calif.

(Continued on page 196)



This illustration shows Fafnir Flangette installations on the separator shell of the No. 141 Harvester-Thresher, including the main cylinder and beater shafts.

Low-cost prescription for raising farmers' net-income



THE FLANGETTE

In designing the No. 141 Harvester-Thresher, the International Harvester Company specified the wide use of ball bearings with lubricant permanently sealed in. The majority of all bearings are this type; many of which are Fafnir Flangettes. The use of such bearings cuts the combine's non-productive time to a minimum . . . no time out for lubrication. What's more, it means that the initial investment pays bigger dividends, longer . . . because the combine lasts longer.

Fafnir Flangette bearings are available with either Mechani-Seals (slinger type) or Plya-Seals (contact type). In addition to their anti-friction advantages, they offer important cost-saving advantages. Their initial cost and cost of installation are low — that's why Fafnir Flangettes are so popular with manufacturers and farmers alike.

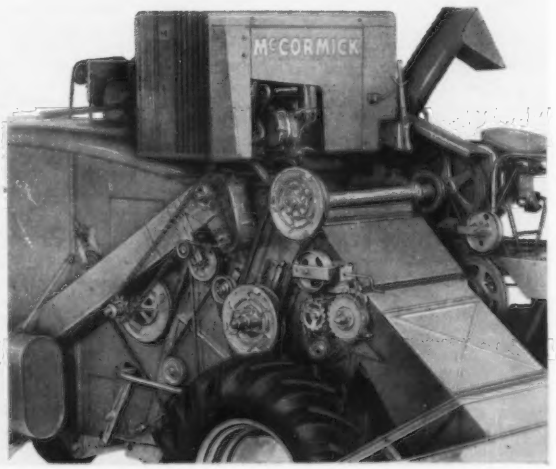
If you are on the lookout for economical ways to improve farm equipment, be sure you have up-to-the-minute facts about the Fafnir Flangette. The Fafnir Bearing Company, New Britain, Connecticut.

This illustration shows a view of the Harvester-Thresher separator shell all assembled and ready for business.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

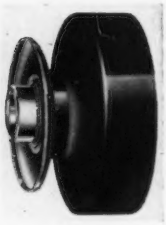


New Products and Catalogs

(Continued from page 194)

Automatic Clutch for Electric Motors

Mercury Clutch Division, Automatic Steel Products, Inc., Canton, Ohio, has developed a new automatic clutch for 1/6, 1/4 and 1/3-hp electric motors. The new clutch uses one moving element to reduce the length of sustained inrush current and permits the motor to reach full speed before any load is applied. The standard model has a 5/8-in bore and a pulley size of 2½-in x 1A. Data on special pulley sizes and other pertinent information on specific applications are available from the manufacturer on request.



Self-Propelled Forage Harvester

Gehl Bros. Mfg. Co., West Bend, Wis., has introduced a new big-capacity, self-propelled forage harvester. The basic unit is made up of a standard model forage harvester which provides the chopping mechanism and the propelling unit is driven by either an 87-hp or a 109-hp Continental engine. Individual hydraulic brakes are provided. The operator has finger-tip control of traction drive and front-end lift. The suspended front wheels are hydraulically interconnected.

The self-propelled model can be equipped with the standard 2-row crop head, 6-ft mower bar, and hay pickup. All three are standard Gehl attachments that can be changed in a few minutes.

Increases Sprinkler Line

The Skinner Irrigation Co., 1001 Water St., Troy, Ohio, has announced additions to its line of agricultural sprinklers with the new S-600 one-nozzle and the S-650 two-nozzle models.

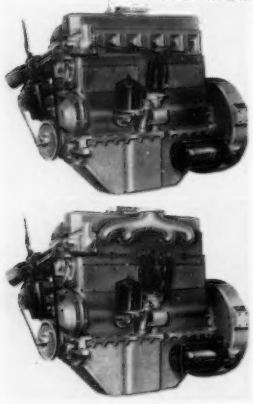
A neoprene sleeve on the driving nozzle absorbs the impact at the point where the oscillating arm contacts the body — there is no metal to metal contact. The neoprene sleeve can be replaced by removing the nozzle. The deflector is also made of neoprene. The speed of rotation can be varied by an adjustment of the oscillating arm spring. A special grit-guard bearing is available for use in areas where abrasive sand is a problem.

Four New Engine Series

The Hercules Motors Corp., Canton, Ohio, has announced production on four new series of gasoline and diesel engines to augment its lines of spark and compression-ignition engines. The four new series, includes 12 new models in 4 and 6-cylinder construction providing the company with four distinct types of optional power in which interchangeability as units and extensive interchangeability of parts have been stressed.

The new models include a new line of overhead valve gasoline engines, known as the G.O. series, available in three different bore sizes in both 4 and 6-cylinder construction, and a new line of direct-injection diesels, known as the D.D. series, also available in three different bore sizes in 4 and 6-cylinder construction to match the G.O. series. (Horsepower ratings: 4-cylinder gasoline-67, 76 and 87 hp; 6-cylinder gasoline-102, 114 and 131 hp; 4-cylinder diesel-50, 57 and 65 hp; 6-cylinder diesel-75, 85 and 99 hp.)

The illustration shows the similarity of the G.O. and D.D. engines (*top*, 6-cylinder gasoline, *bottom*, 6-cylinder diesel). Cylinder blocks not only are interchangeable between gasoline and diesel engines of like size, but were so designed that they can be turned end for end and the flywheel housing and gear cover bolted to either end, thus permitting the power to be taken from either end of the engines. This further permits the shifting of manifolds and accessories to either right or left-hand side.



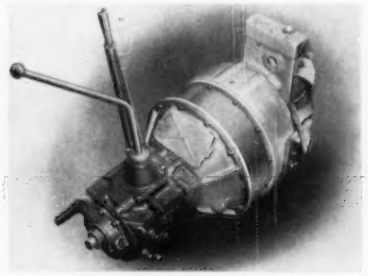
Because of the extensive use of common components, it is also possible to change an engine built as a gasoline unit into the diesel type by simply changing the pistons; cylinder head castings (valves and guides remain the same); spark plugs and distributor for fuel injection nozzles and fuel injection pump; governor arrangement, and manifold and carburetor on the gasoline engine for the air intake and exhaust manifold on the diesel engine. The use of the same cylinder blocks, crankshafts, connecting rods, oil pans and front and rear ends of the engines of like size and the same valves, camshafts and valve operating mechanisms are used interchangeably in the gasoline and diesel units. Compression ratios are varied by changing pistons. In the diesel units, combustion space is arranged in the crown of the piston, properly lined up with the axis of the fuel injection nozzles.

Common to the two different types of engines is a common mounting for the distributor in the case of gasoline engine and the single-plunger fuel-injection pump on the diesel. Thus, the distributor and fuel-injection pumps are to be found in identical positions on the two types of engines. The oil pump-driven gear is used as the drive coupling for either the fuel-injection pump on the diesel or the distributor on the gasoline engine.

All pistons are aluminum alloy and anotinned. Cylinder blocks are designed fully symmetrical to make both ends identical. Dry liners or cylinder sleeves are provided for the 3½ and 3¾-in bore engines and can be inserted with a push fit. The 4-in bore engines are furnished without sleeves.

New Fluid Coupling

Continental Motors Corp., 205 Market St., Muskegon, Mich., has introduced a new hydraulic coupling which features overload protection, high power factor, and smooth acceleration. The new coupling is designed to transmit power and torque through a fluid for use on compressors, conveyors, blowers, cranes, crushers, pumps, winches, road equipment and other similar applications.



Loader for Tricycle Tractor

Tractor and Implement Div., Ford Motor Co., Birmingham, Mich., has announced a new farm loader designed to mount in less than two minutes on any Ford tricycle tractor.

The new loader features 1,000-lb load capacity, quick lifting, compactness and step-on design. The vertical frame members supporting the loader arms are more than 14 in ahead of the rear fenders, providing ample room for the operator to step directly on or off the tractor.

The over-all height is 5 ft, 8 in, and over-all length is 14 ft, 6 in. No chain falls or hoists are needed to attach or detach the new loader. Adjustable leg-type mounting and dismounting stands are built into the loader frame as standard equipment and automatically support it in the correct attaching position. In addition, quick disconnect self-sealing couplers make it possible to connect or disconnect the hydraulic hoses quickly without losing oil. Loader operation is controlled by the operator from the tractor seat through the tractor hydraulic system. *(Continued on page 202)*

TORRINGTON

NB SERIES NEEDLE BEARINGS

For Oscillating Motion or Heavy Rolling Loads

Torrington NB Series Needle Bearings employ the same needle roller principle as the famous DC Type Bearing.

They are available in the five types illustrated, all being of nonseparable construction and designed for periodic relubrication. Outer and inner races are of high carbon, chrome steel, hardened and precision ground.

Like the DC Type, the compact design of NB Series Needle Bearings permits saving in size and weight of surrounding parts.

Torrington NB Series Needle Bearings have been used extensively in the aircraft industry and for ordnance work where their extremely high static capacity and anti-friction characteristics enable them to withstand heavy impact loads.

Designs can be modified to meet industrial applications involving rotating motion.

Type NBC—oscillating motion only. Designed specifically for applications in which the OD is supported by a housing and the washers are backed up by clamping surfaces.

Types NBE and NBK—oscillating motion only. Self-aligning. Designed for applications where it is difficult to obtain alignment during assembly or where deflections make a self-aligning bearing desirable.

Types NBF and NBL—heavy rolling loads. Designed for use as rollers under heavy loads at slow speeds.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

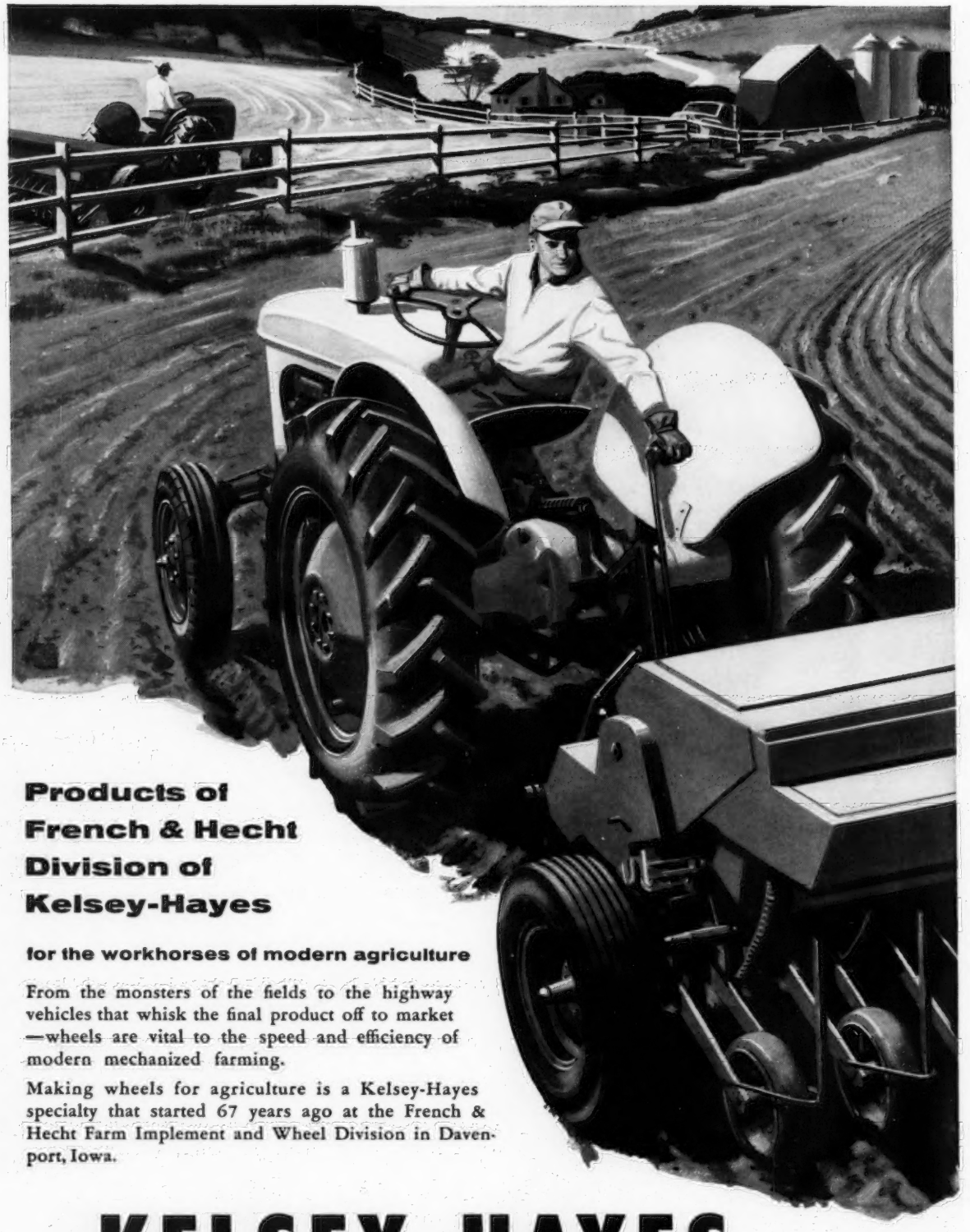
THE TORRINGTON COMPANY

Torrington, Conn. **South Bend 21, Ind.**

District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Needle • Spherical Roller • Tapered Roller
Cylindrical Roller • Ball • Needle Rollers



Products of French & Hecht Division of Kelsey-Hayes

for the workhorses of modern agriculture

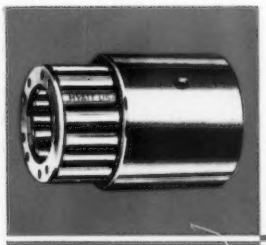
From the monsters of the fields to the highway vehicles that whisk the final product off to market —wheels are vital to the speed and efficiency of modern mechanized farming.

Making wheels for agriculture is a Kelsey-Hayes specialty that started 67 years ago at the French & Hecht Farm Implement and Wheel Division in Davenport, Iowa.

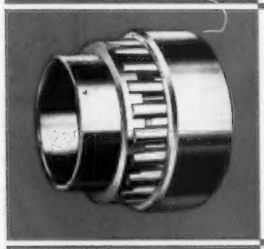
KELSEY-HAYES

Kelsey-Hayes Wheel Co., Detroit 32, Mich. • Major Supplier to the Automotive, Aviation and Agricultural Industries

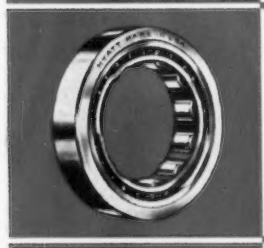
TEN PLANTS / Detroit and Jackson, Michigan; McKeesport, Pa.; Los Angeles, Calif.; Windsor, Ontario, Canada • Davenport, Iowa (French & Hecht Farm Implement and Wheel Division) • Springfield, Ohio (SPECO Aviation, Electronics and Machine Tool Division)



TRUNNIONED ROLLER CAGE—Economical for volume use on thin-annulus bearings. End rings are hardened steel stampings, connected by riveted bars interspersed between rollers to form an integral unit. Races can be omitted if desired.



POCKETED END RING CAGE—Designed for fairly large bore bearings in heavy-duty service. Rollers are guided accurately by pockets drilled in bronze end rings. Riveted connecting bars form an integral unit, so races can be omitted if desired.



STAMPED STEEL SEPARATOR—Economical for volume use on wide range of bearings with short rollers. A single steel stamping with bars coined to conform to roller contour. Simple, open design assures large lubricant capacity and good circulation.

FORMED BAR CAGE—Well adapted for volume use on heavy-duty bearings. Hardened steel end rings are connected by cold-rolled shaped bars conforming to roller diameter. Insures quiet operation, better roller guidance, and the smooth surface of bars protects rollers.

DRILLED POCKET CAGE—Used on better-grade bearings to provide extremely close control of rollers, which operate in pockets drilled and reamed in bronze cylinder. Riveted ring on one end retains rollers permanently, so races may be omitted if desired.

SEPARABLE BROACHED POCKET CAGE—Used only on finest high-speed bearings. An integral bronze cylinder with pockets broached for maximum uniformity. Insures minimum friction, better oil circulation for cooling. Rollers can be removed for inspection.

NON-SEPARABLE BROACHED POCKET CAGE—Similar to the above and offers all the same operating advantages. Used for "blind" installations where rollers must be retained with inner or outer race. Roller drop controlled by deforming bars after rollers are placed.

What makes a cylindrical roller bearing good?

When you buy a roller bearing, you expect it to do a certain job for you. How well it does that job depends on many different factors. This series of messages is designed to help you recognize some of these important differences and get more for your bearing dollar.

The RIGHT KIND OF RETAINERS for the application

The basic parts of a roller bearing are the rollers, the races, and the *retainer* which locates and guides the rollers. There are significant differences in the design and construction of retainers, which influence bearing cost and performance. Some are simple and economical, well adapted for volume production; others are more costly but insure improved roller guidance, or cooler and smoother operation, or longer heavy-duty service. Beginning with the most economical, here are the seven basic types in current use:

HYATT MAKES ALL SEVEN TYPES . . . EACH THE FINEST OF ITS KIND! **You will find complete details in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your requirements. Remember, HYATT is America's *first* and *foremost* maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors, Harrison, N. J.**

GM GENERAL MOTORS

HYATT

ROLLER BEARINGS

the CAT* TOOL BAR way!

Soil Conservation specialists, farm power contractors and farmers open new horizons of soil productivity by the deep placement of dry and gaseous fertilizers.

This is a simple, easy job for any Cat Diesel Tractor, from the 38 DBHP D2 to the 230 DBHP D9. For example, pulling a pair of Cat Subsoilers placing fertilizer 8" to 24"deep is hard work. Yet, in many soil conditions the 38 DBHP Cat D2 Tractor handles the job efficiently.

Farm power contractors find new profits in the use of deep fertilizer placement equipment on the Tool Bars of Cat Diesel Tractors. Conservation-minded farmers also find this profitable. They immediately realize many other advantages, too. No more worries about getting stuck. Abundant power to handle bigger tillage jobs and accomplish much more than is possible with ordinary farm tractors of similar horsepower. The ability to clear land and fence rows, improve pastures, move dirt.

Your Caterpillar Dealer has the tractors and matched equipment you need to enlarge your operation ... to make more money ... to conserve soil and water. See him soon!

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

This Caterpillar D2 Tractor with Tool Bar places anhydrous ammonia at a rate of 2½ to 3 acres per hour. The fertilizer flows through a tube behind each of two subsoilers spaced 50" apart. The tools and the tank are lifted clear of the ground at the touch of a hydraulic control lever.

FREE BOOKLET: "Big Hitches & Tool Bars"— shows how large, efficient tractors can do more work in a shorter time. Ask your dealer or write Caterpillar Tractor Co., Dept. AE36, Peoria, Ill.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

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***FARMERS * CONSERVATIONISTS**
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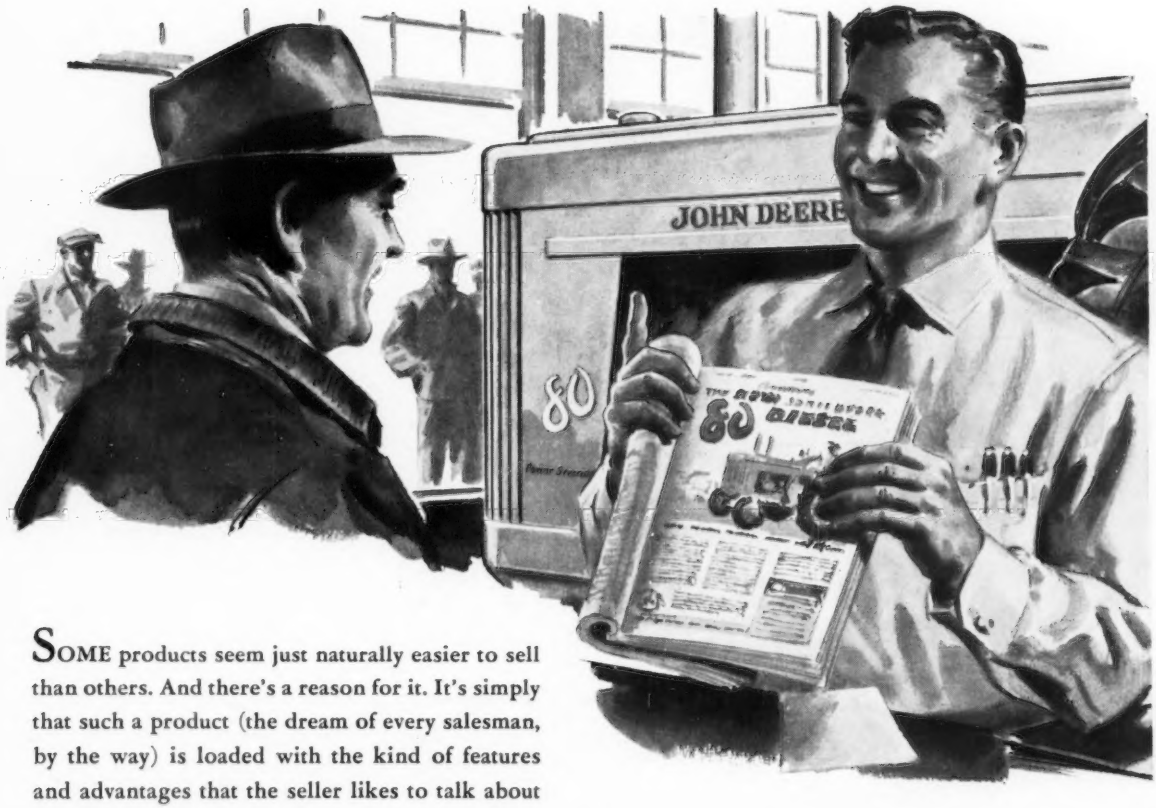
***CATERPILLAR DEALERS**

"Another Powerful Subject for Me to Talk About"



SOME products seem just naturally easier to sell than others. And there's a reason for it. It's simply that such a product (the dream of every salesman, by the way) is loaded with the kind of features and advantages that the seller likes to talk about and the prospect likes to hear.

The new John Deere Model "80" Diesel Tractor is a good example. Power with economy, comfort with performance, convenience with dependability—all are qualities that make this tractor literally "speak for itself" and that contribute so fully to downright good sales conversation.

In all of these qualities, of course, the new Model "80" is typical of the complete John Deere line of modern farm equipment—equipment designed, built, and known the country over for fulfilling the anticipated machinery needs of the progressive farmer.

The new Model "80" Diesel is the extra-value tractor in the 5-plow field, offering big-tractor power at rock-bottom operating costs.

JOHN DEERE QUALITY FARM EQUIPMENT

JOHN DEERE • Moline, Illinois

QUALITY FARM EQUIPMENT SINCE 1837

WHITNEY SELF-LUBRICATING AGRICULTURAL CHAIN SETS NEW PERFORMANCE STANDARDS . . .

Now you can equip all farm machinery using conveyor or transmission type roller chain with Whitney's revolutionary *Self-Lubricating* Chain . . . the agricultural chain that assures lower maintenance and longer life.

WHY Stud Bushings In Whitney Agricultural Chain?
By replacing conventional chain rollers with sintered stud bushings, Whitney Agricultural Chain provides additional lubricant storage area for prolonged self-lubricating service.

Whitney *Self-Lubricating* Agricultural Chain has high strength, pre-lubricated sintered steel bushings that oil from the *inside*. The tougher the usage, the more lubrication to vital chain points. *Self-Lubricating* Chain is self-cleaning . . . has controlled plate clearance to eliminate "freezing."

Whitney *Self-Lubricating* Agricultural Chain, made of premium materials is engineered for all types of farm machinery. They are completely interchangeable and interlace with A.S.A. double pitch chain.

ANOTHER example of Whitney leadership. Whitney will gladly assist in determining the chain best suited to your requirements.

For full information, write —

Whitney
CHAIN COMPANY
246 HAMILTON STREET, HARTFORD 2, CONNECTICUT

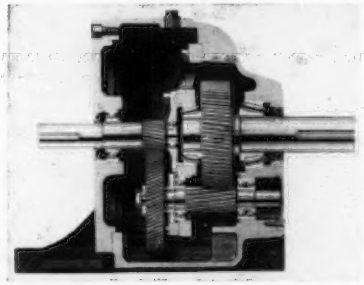
New Products and Catalogs

(Continued from page 196)

In-Line Reduction Gears

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has developed a new line of in-line helical gear drives. Double reduction drives are available in ratios from 6.2 to 1 through 38.4 to 1, with capacities up to 118 hp. Triple reduction drives are available in ratios from 47.1 to 1 through 292 to 1, with capacities up to 20 hp.

Features of the new drives include a one-piece cast iron housing, with oil seals at

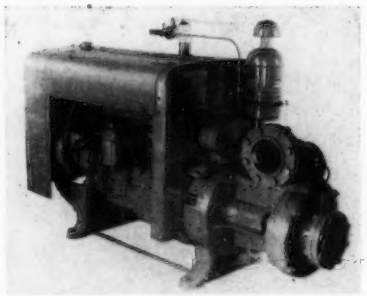


shaft openings. The cast iron construction has inherent sound deadening properties. The input and output shafts are located in the same horizontal and vertical planes and all moving parts are splash lubricated and permanently aligned.

Complete information about these new in-line helical gear drives is found in a free 16-page book No. 2651. It contains cutaway views of both the double and triple reduction drives, together with instructions for proper selection, load classes for over 250 applications, overhung load ratings and dimension tables. Copies may be obtained by writing Link-Belt Co., Dept. P.R.

Expands Pump Line

The Ralph B. Carter Co., 192 Atlantic St., Hackensack, N. J., has expanded its line of Humdinger, self-priming centrifugal pumps to include a wide selection of types and sizes for irrigation requirements. Pumps range in size from 3x2½-in to 5x5-



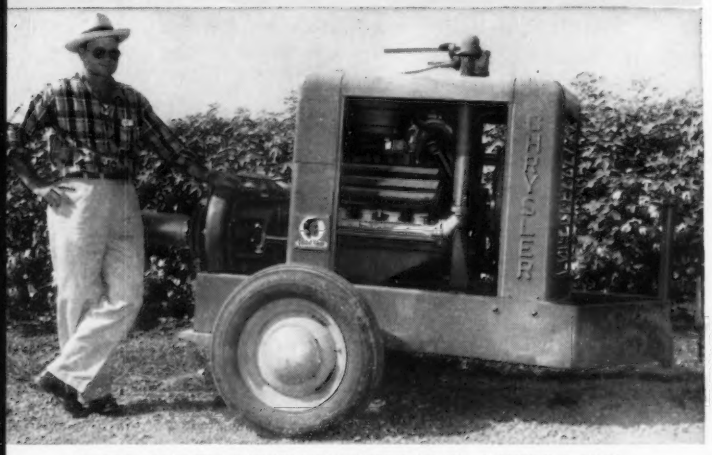
in models. Close-grained, cast-iron impellers and pump cases are used to minimize electrolytic action of dissimilar metals in the event chemical fertilizers are injected into water during the pumping cycle. Other features include oil-lubricated mechanical seals, double-ball-bearing-supported shafts, and pump-to-engine adaptor assemblies.

Models are available as fully equipped package units powered by a large choice of engines, or as independent pumping units designed for coupling to any standard engine or PTO arrangement.

(Continued on page 204)

Doubles Cotton Yield per Acre

J. H. Pruett, Lyon, Mississippi, shows you the kind of cotton you can expect, given proper cultivation and controlled irrigation. Below, Pruett with his Chrysler-powered Barnes Irrigation Pump.



PHOTOS COURTESY BARNES MANUFACTURING CO., MANSFIELD, OHIO

J. H. Pruett, Lyon, Mississippi, averages 2.3 Bales of Cotton per acre with Chrysler-powered Barnes Irrigation Pump.

Last spring, J. H. Pruett, whose 626-acre farm is located on rich Mississippi River delta land, installed a Chrysler-powered Barnes Irrigation Pump. During the May to July growing season he irrigated 190 acres of cotton and 46 acres of pasture, taking water from a nearby creek.

Pump ran eighteen hours a day every day of the growing season, using butane fuel. A steady pressure of eighty pounds per square inch was maintained at the pump head. Pumping at the rate of 1250 gallons per minute, approximately 1,350,000 gallons of water were sent through the sprinklers every 18-hour day.

Pruett writes, **"Cotton needs water very badly at certain stages of growth. With controlled watering, our 1955 cotton crop will average out at 2.3 bales per acre compared to .8 bales per acre in 1954 without irrigation. Irrigating pasture land pays off too. Grass stays green longer — it's cut down the feed bill for our Hereford cattle."**

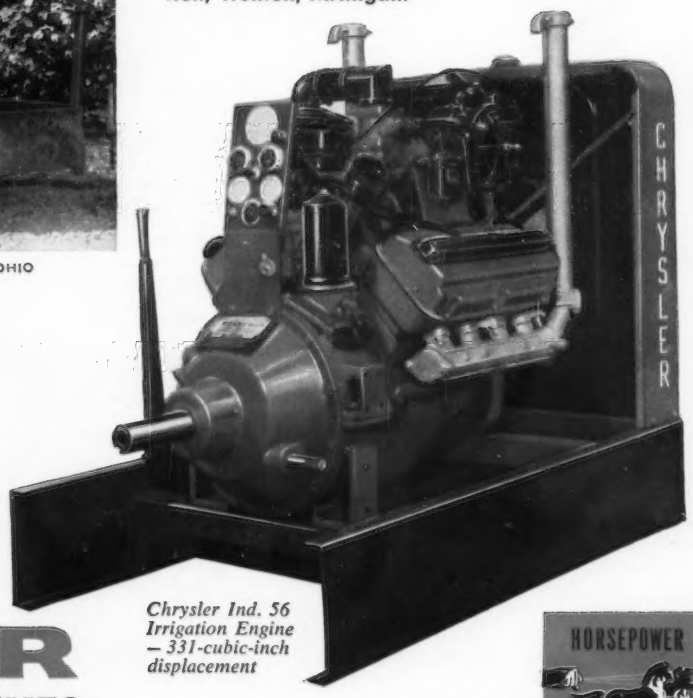
What J. H. Pruett of Lyon, Mississippi, is doing with supplemental irrigation — you can too. And when you pick a pump, check to see that a Chrysler Industrial Engine powers it. For further information, see a Chrysler Industrial Engine Dealer, your pump dealer, or write: **Dept. 163, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.**

Gus Grower Says:

"Fellows, before you lay up the irrigation system, follow this simple procedure and you'll be all ready to start up next spring.

"First, drain the radiator and engine block. Drain oil out of the crankcase and refill with clean oil of the grade and weight you ordinarily use. Then remove spark plugs and put a couple of ounces of SAE 30 oil into the cylinder bores. Rotate engine with starter enough to spread the oil over the bores. Then clean and reinstall spark plugs. Tape exhaust pipe opening and remove air cleaner and tape the intake to the carburetor or the L-P-G mixer, (whichever you have).

"In the spring remove tape, reinstall air cleaner and start her up."

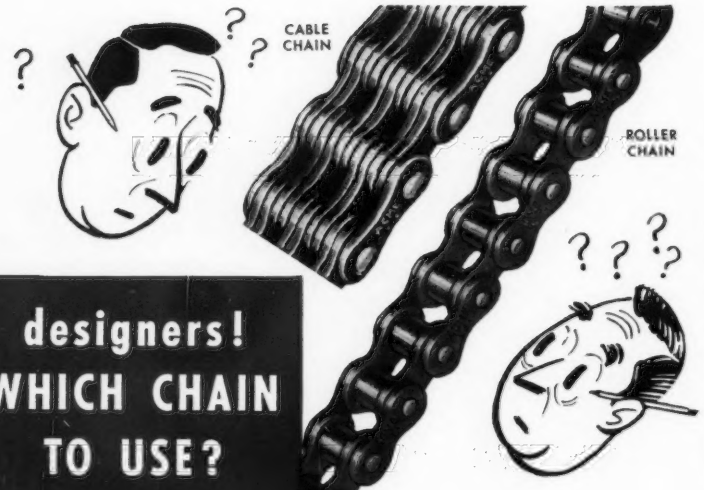


Chrysler Ind. 56 Irrigation Engine — 331-cubic-inch displacement

CHRYSLER

INDUSTRIAL ENGINES INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER WITH A PEDIGREE



designers! WHICH CHAIN TO USE?

CABLE or ROLLER?

Cable chains are used for special purpose applications where roller chains are not required. They are suitable for any kind of tension linkage applications such as counterweight mechanisms, elevator doors, lift trucks, pipe wrenches, etc. Cable chains give a greater ultimate strength for a given chain weight, size, and cost than any other type of chain.

ACME's chain engineers can advise you of the correct chain selection, that may save you both dollars and time. For any task involving chain, don't hesitate to get the free assistance of ACME chain engineers.

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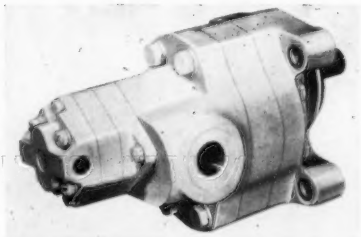
New Products and Catalogs

(Continued from page 202)

Tandem Pump Unit

Webster Electric Co., Racine, Wis., has introduced a new tandem pump using two hydraulic pump units in one compact assembly. The new pump tandem permits initial use of the larger pump alone with a cover plate, and later the use of a smaller pump without the need of additional inlet piping.

The pumps, when used in tandem, operate from a common driving medium. This is

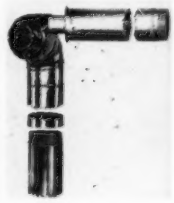


accomplished by mating the shafts of the two pumps. A common inlet reduces the amount of hydraulic piping. Typical combinations of the tandem assembly range in length from 8$\frac{3}{32}$ to 10$\frac{1}{16}$ in.

Capacities of the tandem pump combinations range from 4.8 to 29.0 gpm at 1000 psi for the larger pump in 1750-rpm installations; and from 1.0 to 4.0 gpm at 1000 psi for the smaller pump. The smaller pump normally is the one used in power-steering installations.

Grain Bin Aerator

George A. Rolfes Co. of Boone, Iowa, has introduced a new aerator for farm-type grain bins.



Called the Powerator, the new blower system consists of a 110-v, 3350-rpm blower attached to a 10-ft perforated tube which is inserted downward into the center of the bin. Fresh air is drawn through the grain, into the 5-in diameter perforated tube and out through the blower.

Double-Action Truck Hoist

Lundell Mfg. Co., Cherokee, Iowa, has developed a new truck hoist which uses two-force action. The power on both ends of

the 5 or 6-in cylinder is controlled to give a push and pull action. One end of the cylinder exerts a pushing pressure while the other pulls the load.

The new hoist has been designed to handle 8 to 9-ton capacity. Hoists are available to fit all standard truck boxes, it is said.

(Continued on page 206)

Ask the farmer's son . . .

he'll tell you why it's easier to sell a gasoline tractor.

The farmer's son wants to go to agricultural college. He also needs clothes and occasional medical care. The farmer wants his son to have these things, but they take money . . . money that must also pay for a new farm tractor.

Why not make it easy for the farmer to see his way clear for both of them to have what they want. The lower purchase price of a gasoline tractor can often make this possible. And it can win a sale for you.

Price is only one of the many advantages that today's gasoline tractors deliver. They boast power increases up to 30% . . . greater all-around convenience . . . less costly maintenance. And at trade-in time, they have top value.

So next time, remember the farmer's son . . . he can swing a sale for you.

ETHYL CORPORATION

NEW YORK 17, N. Y.

New Products and Catalogs

(Continued from page 204)

Four New Tractors

Massey-Harris-Ferguson, Inc., Racine, Wis., has introduced four new models to its line of farm tractors—MH50, 333, 444, and 555.

The MH50 (illustrated) is a 2-3 plow tractor with a 134-cu-in, 4-cylinder, overhead-valve engine. Power and control units perform twin functions. Flexibility to farming operations is gained by doubling up on clutch, transmission, PTO and hydraulic control.

The company reports that a weight-transfer system automatically creates traction

matched to the demands of load and soil conditions. As the tractor moves through the field, the 3-point hitch becomes an automatic depth control. An actuator uses ground pressure, transmitted through the upper link, to match pull-power to the load. This control is said to prevent a plow, for example, from digging too deeply or shallowing up as soil texture changes. While this automatic control is occurring, the net result is an increase in traction, it is said. The mounted implement does not rest on the soil below it, but is carried on the 3-point hitch. The MH50 has a 2-speed transmission that offers a choice of six forward and two reverse speeds. A one-pedal, two-range clutch controls the PTO, transmission and hydraulic pump. Pushing the pedal through its first range disengages the clutch to stop the forward motion of the tractor while the PTO continues to operate. Both the PTO and tractor are stopped when the pedal is pushed completely down. Other features include power-adjusted rear wheels, optional power steering, hood-high air intake, 12-v electrical system, adjustable tilt-back seat, and an hour, speed and rpm tractormeter. Four interchangeable front wheel styles are available: row-crop utility, high arch, twin front and single front.

The 4-row 333 and 444 tractors are designed as successors to the former models 33 and 44 special, while the 555 is designed for large farm operations. Features include 10 forward speeds, 2 reverse, power-adjusted rear wheels, optional power steering, 12-v electrical system, level-drive PTO, and 3-point hitch.

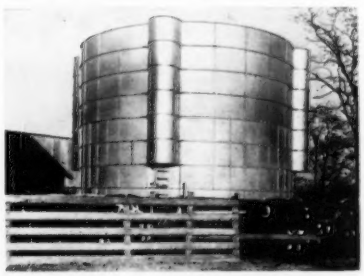
A new 208-cu-in-engine powers the 333; the 444 retains the 277-cu-in power plant of the 44 special. Both are available in gasoline, diesel, and LP models.

The 5-plow 555 features a 382-cu-in engine in gasoline, diesel and LP models. It incorporates a new transmission case, as well as improved gears, 12-v electrical system and optional power steering.

New Steel Silo

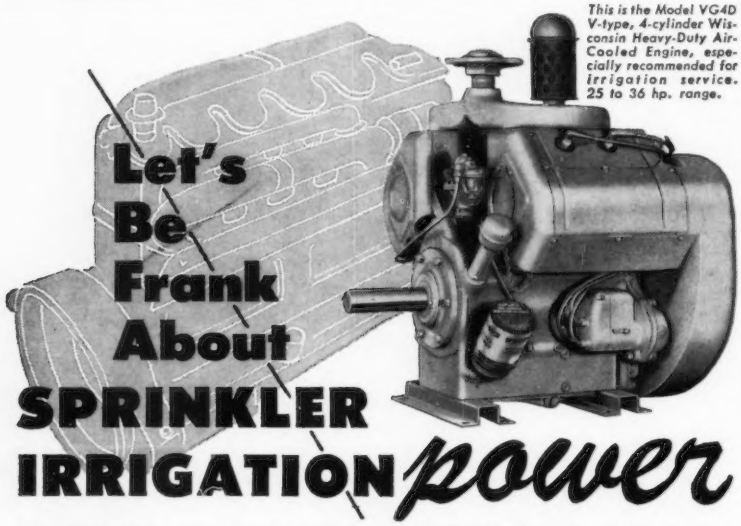
Martin Steel Products Corp., Mansfield, Ohio, has announced a new large-diameter steel silo designed to provide the capacities of horizontal and trench-type silos.

Capacities of these new silos range from 272 to 508 tons. The silo shown has a diameter of 30 ft and a capacity of 400 tons. Four rows of doors and chutes were installed so that 90 percent of the silage is within 10 ft of a door opening. A feed bunk extends around the entire circumfer-



ence of the silo at the ground, and it is necessary only to spread silage both ways from the bottom of each chute at feeding time.

The new silo is built of preformed galvanized steel sheets which are bolted together at the site. Initially two diameters of 24 ft, 8 in and 29 ft, 7 in are being offered in three heights—24 ft, 9 in; 27 ft, 6 in, and 30 ft, 3 in. Sidewall sheets are reinforced to withstand the pressures produced in storing silage in these quantities. At present, no roof is being offered for these silos. The manufacturer reports that experience with experimental silos has not indicated that a roof is needed.



This is the Model VG4D V-type, 4-cylinder Wisconsin Heavy-Duty Air-Cooled Engine, especially recommended for irrigation service. 25 to 36 hp. range.

Let's Be Frank About SPRINKLER IRRIGATION *power*

As irrigation power units go today . . . whether big diesels for large scale irrigation, or so-called "Small" engines for portable service and limited acreages . . . there is one characteristic these power units should have in common. Next to selecting a unit of the most efficient and economical size to fit your requirements, the most important point to consider is HEAVY-DUTY SERVICEABILITY.

Wisconsin Air-Cooled Engines (3 to 36 hp.) are HEAVY-DUTY power units . . . in all details of design, construction and operating stamina. You can expect and *get* the same rugged, consistent performance from these engines hour after hour, day in and day out, as you would get from the very largest power units. These engines are actually "tailor-made" to meet the exacting demands of sprinkler irrigation service.

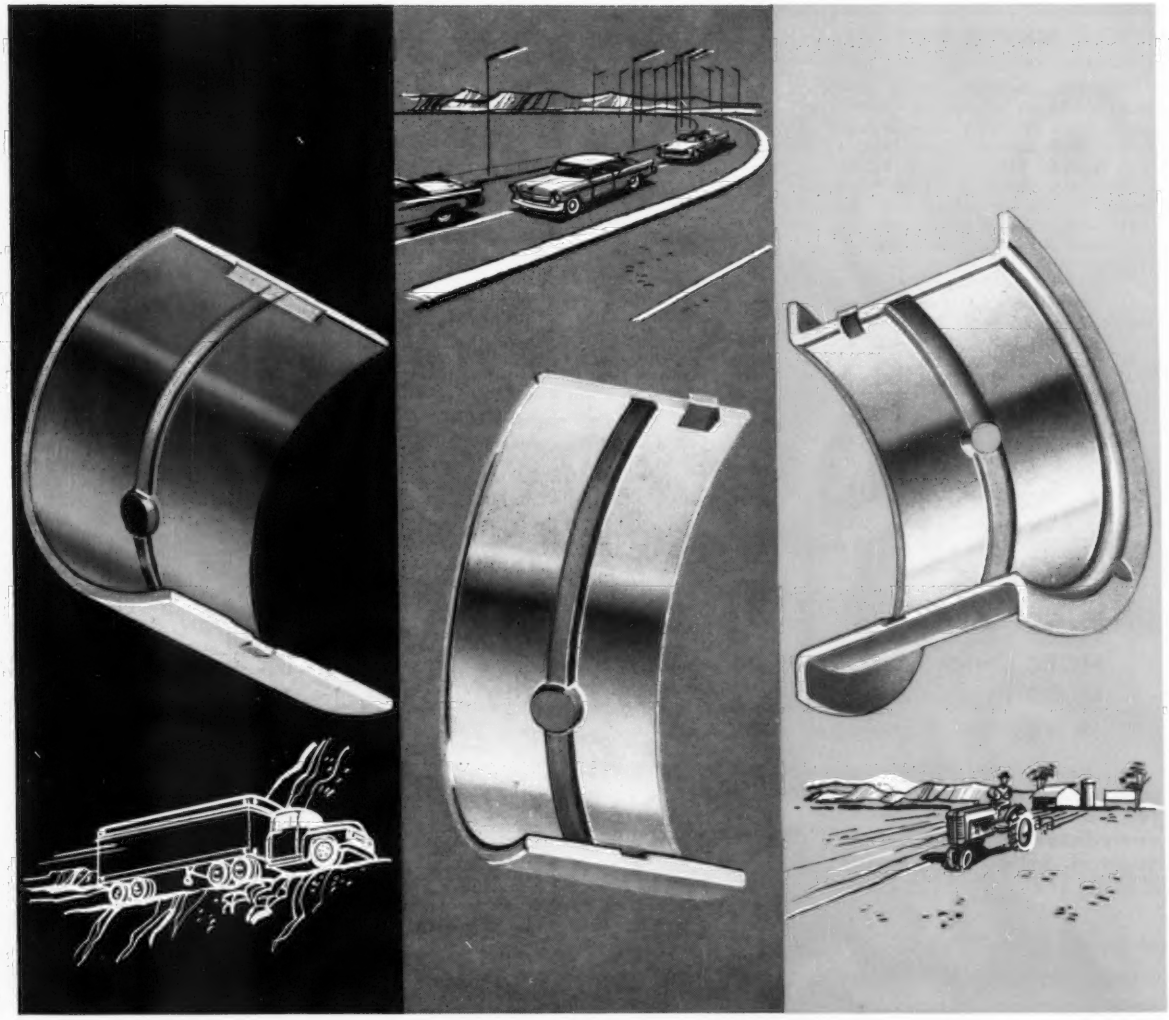
BUT — regardless of the size or type power unit, be sure the system is engineered by competent personnel, fully familiar with all the necessary factors that must be considered when a satisfactory and successful irrigation pump installation is made. Determine the limits of your irrigation system regardless of the gas engine horsepower or size. Know just how much *extra service* has been engineered into the system for maximum economy of operation and trouble-free performance.

This is a specialized type of service, calling for specialized experience and knowledge . . . and Wisconsin Heavy-Duty Air-Cooled Engines should be basic units in any sprinkler irrigation systems within their power range. Write for Folder S-181.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN



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NEW BOOKS

Magnetic Materials in the Electrical Industry, by P. R. Bardell. Cloth, 288 pages, 5½ x 8½ inches. Illustrated and indexed. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. $10.00.

This book should be of great help to senior students in physics and electrical engineering and to physicists and engineers in industry as a guide in exploring the complexities or "mysteries" of magnetism. A glossary of terms and units at the end of the book, tables showing the properties of materials, and a note explaining magnetic terminology have been included to better acquaint the reader with the subject. Chapters cover an introduction; theoretical considerations; permanent magnet materials; high-permeability (soft) magnetic materials; measurements on soft magnetic materials; power-frequency applications of soft magnetic materials; communication-frequency applications of soft magnetic materials; magnetic recording; testing of materials by magnetic means; magnetic amplifiers (transductors); and transducers.

Rural Electrification (Fifth revised edition) by J. P. Schaenzer. Cloth, vi + 378 pages, 6 x 9 inches. Illustrated and indexed. The Bruce Publishing Co., Milwaukee 1, Wis. $3.75.

This book is written especially as a text for secondary school use, but should be of value to college students, farmers, vocational schools, and the rural-service men or farm use advisors of the electric power suppliers. Special emphasis has been placed on presenting the material in the best teachable form. Each chapter or lesson has been divided into sections to best serve that purpose. These sections are class discussion, equipment, demonstration, practice and problems, information, and suggested readings.

Chapters include electricity, the silent partner; how electricity is made and distributed; serving the farm customer; wiring materials, maintenance and repair; wiring the farmstead, home, barn and outbuildings; electric motors and fractional-horsepower motor applications; and a chapter for each of several uses of electricity on the farm.

Modern Surveying for Civil Engineers (Second edition revised) by Harold F. Birchal. Cloth, xi+528 pages, 5½ x 8½ inches. Illustrated and indexed. Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. $15.00.

The aim of the book is to deal with the subject of surveying in a practical and specialized manner for use in the field or in the office. The new edition follows the first edition by 20 years. Much new data on the latest surveying instruments and methods are incorporated. Such modern methods as photographic and aerial surveys are dealt with in detail. The first chapter is a refresher of the fundamentals. Other chapters deal with chaining, levelling, angular measurements, tacheometry, cross sectioning, forest surveying, stadia traverse, contours, irrigation surveys, tunnels, bridges, viaducts, reconnaissance surveys, survey party rules and regulations, estimates, curves, railway points, photography and aerial surveying. The book is printed in Great Britain.

Steels for the User (Third edition) by R. T. Rolfe. Cloth, xvi 399 pages, 5½x8½ inches. Illustrated and indexed. Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. $10.00.

The book is written to present simple explanations of complex processes, thereby providing a better understanding between science and practice for carbon steels in industry. The scientific aspects of the various processes are treated comprehensively, but illustrated by ample data and examples from actual service. The work deals substantially with carbon steels. Alloy steels are discussed only for duties for which carbon steels are unsuitable. The 12 chapters cover mechanical quality, specified requirements, composition, bright and free-cutting, heat treatment, case hardening, use at elevated temperatures, fatigue testing, weld testing and treatment, and general principles of selection.

Journal No. 7 of the Kanto-Tosan Agricultural Experiment Station, (May, 1955) Konosu, Saitama, Japan. Paper, 212 pages.

Contents include the following: Studies on weed control in rice culture by 2,4-Dichlorophenoxyacetic acid, parts V and VI (part V for various cultivation, part VI for different climates); Studies on transplantation of rice seedling in non-preparation of land; Survey on the paddy field works of villages on Nakagawa basin in Saitama perfecture; The research group in Kanto-Tosan Agricultural Experiment Station on wheat and barley cultivation in paddy fields; The effects of fertilization, plant population and irrigation on the growth and yield of upland rice; The after effects of irrigation in summer on the growth and yields of the succeeding barley crop; Studies on harvesting machines; Morphological studies on cannons of horses; Studies on the improvement of grass growth under farm woodlands due to selective cutting system; and Fertilizer experiments on pasture and range land.

ROCKFORD

New MORLIFE* CLUTCHES and CLUTCH PLATES Give—

MORE Clutch Life (400% MORE)
MORE Torque Capacity (100% MORE)
MORE Heat Resistance (50% MORE)

These *new* ROCKFORD Clutches and Clutch Plates have been developed by ROCKFORD Clutch Engineers to take full advantage of recently discovered facing material. Actual field tests on heavy duty equipment have resulted in adoption of MORLIFE clutches by builders of tractors, earth movers, graders, shovels, cranes, trucks, oil field equipment and power units. For information how these *new* Rockford MORLIFE Clutches will Improve the operation and increase on-the-job hours of heavy duty machines, write Department E.

*TRADE MARK

"MORLIFE clutch has gone 831 hours without slipping or adjustment."

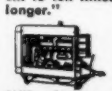
"MORLIFE clutch going strong after 1695 hours, working in sand."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

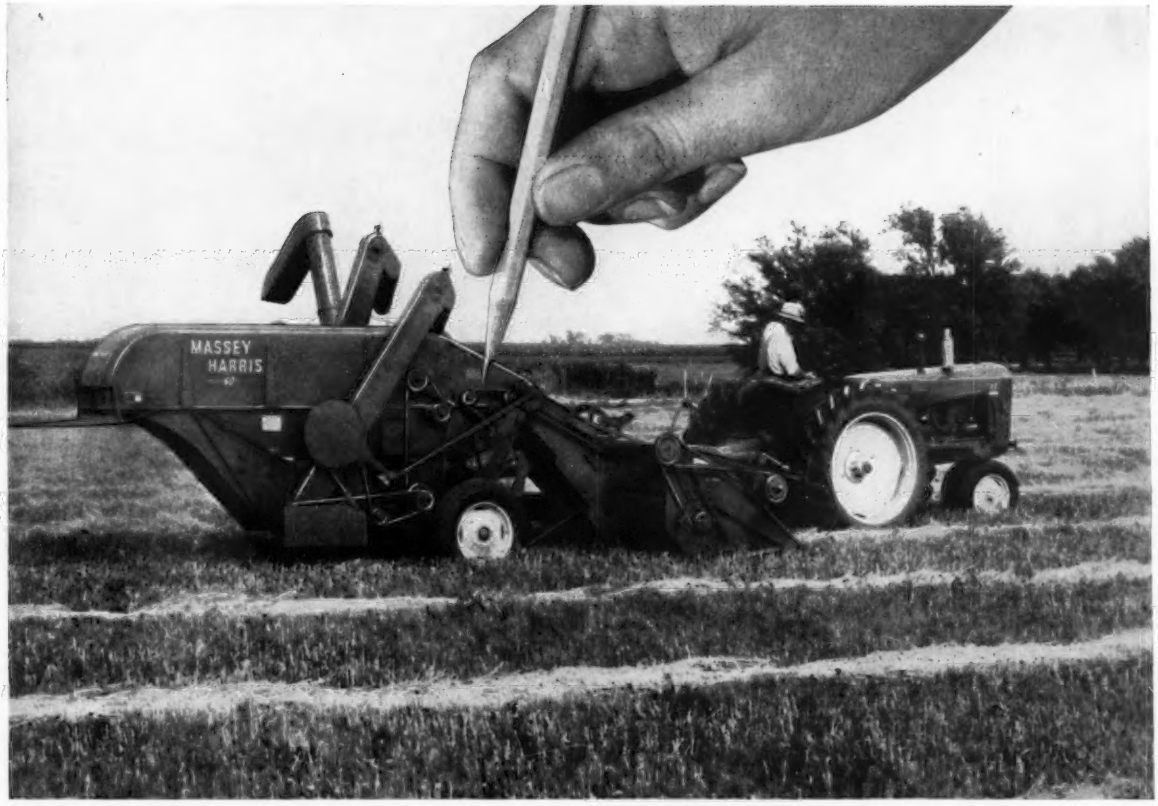
"MORLIFE pulls harder and lasts six to ten times longer."



"Won't buy a unit that isn't equipped with Durable MORLIFE clutch."

ROCKFORD Clutch Division BORG-WARNER
1325 Eighteenth Avenue, Rockford, Illinois, U.S.A.

CLUTCHES



Farm Machine Performance Rides on its Belted Drives

Manhattan belting engineers, working with your engineering department, contribute to the success of your equipment by making its belted drives as nearly foolproof and trouble-free as possible under all operating conditions. Efficient operation of the belted drives can determine the standard of performance of a farm machine . . . and the reputation of its manufacturers. The engineered features of strength, flexibility and long-life built into these belts add up to consistently uniform performance and day-in, day-out dependability where it counts the most — in the field!

More than 60 years research and development in rubber belt drives enable Manhattan to produce the most reliable and economical agricultural drives for the modern machines of today and tomorrow. On all types of power applications, Manhattan Agricultural V-Belts, Condor Whipcord Endless Belts and new, patented R/M Poly-V® Drives meet the most rigid manufacturers' specifications for new and existing equipment designs. Let R/M help you specify the Manhattan agricultural belts to meet your specific requirements . . . to give "More Use per Dollar" to the equipment you manufacture.

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Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Laundry Pads and Covers • Bowling Balls

NEW BULLETINS

How to Build Nailed Trussed Rafters by E. George Stern. Published by *Practical Builder*, 5 South Wabash Ave., Chicago 3, Ill. The 50-page booklet presents a study that shows how to build nailed trussed rafters for most residential requirements. Designs are included for W-type trusses for roof pitches as low as 2 in 12. Designs are based on experimental data obtained in the Wood Research Laboratory of the Virginia Polytechnic Institute (Blacksburg).

Effectiveness of Flooring Nails in Plywood Subflooring by E. George Stern. Virginia Polytechnic Institute (Blacksburg) Wood Research Laboratory Bulletin No. 21 (December, 1955). This is a report of comparative test data to illustrate the effectiveness of flooring brads, cut nails, and helically threaded screw-tite nails, when used for fastening tongue-and-groove hardwood flooring to ⅜-in thick plywood and to such plywood backed-up by sleepers or joists.

Report of Survey of Electrical Equipment on Illinois Farms by the Illinois Farm Electrification Council in cooperation with the agricultural engineering department, University of Illinois. The report covers an account of electrical equipment in use on 70.1 percent of the farms in Illinois. Seven counties had 100 percent returns. Information on types of farms and the percentages of tenant and owner-operated farms has been included. Copies may be obtained by writing R. W. Kleis, Department of Agricultural Engineering, University of Illinois, Urbana. Price is 50 cents.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Boyle, Ralph C.—Chief product engineer, Compagnie Internationale Des Machines Agricoles, 170 Blvd. De La Villette,, Paris 19, France

Clifford, Peter J.—Design engineer, International Harvester Co. (Mail) 512 W. Madison St., Oak Park, Ill.

DeForest, John S.—Editor, *Quonset Farmstead News*, Campbell-Ewald Co., General Motors Bldg., Detroit 2, Mich.

Droke, J. C.—Southeastern sales representative, Ralph B. Carter Co. (Mail) Box 56, Rocky Mount, N. C.

Fellows, Ray J.—Sales manager, Wisconsin Motor Corp., 1910 S. 53rd St., Milwaukee 46, Wis.

Finney, John B.—Agricultural officer (soil conservation), Colonial Agricultural Dept., Northern Nigeria. (Mail) Agricultural Engineering Branch, Regional Research Station, Samaru, Zaria.

Haher, John J.—District manager, agricultural o-e-m div., Dayton Rubber Co., 10814 St. Mark Ave., Cleveland 11, Ohio

Haller, Jr., Earl S.—Civil engineer and engineering specialist (SCS), U.S. Dept. of Agriculture. (Mail) 1111 East 6th Ave., Lancaster, Ohio

Haywood, Kenneth B. — Student engineer in machine design, R. H. Bouligny, Inc. (Mail) RR 5, Asheboro, N. C.

Hohn, Charles M. — Assistant professor, agricultural engineering dept., Texas A & M College, College Station, Texas

Houston, Clyde E. — Extension irrigation and drainage specialist, irrigation dept., University of California, Davis, Calif.

Knight, Sam N.—Farm manager, A. Duda and Sons, 217 N.W. Ave. D, Belle Glade, Fla.

Merrick, David L. — District agent, Martin Steel Products Corp. (Mail) 108 W. Okabena St., Worthington, Minn.

Meyer, Theodore A.—Managing director, Nat'l Assn. of Silo Manufacturers, 131 Breckinridge Lane, Louisville 7, Ky.

Nutt, Arthur — Vice-president of engineering, Lycoming Div., Avco Mfg. Corp., 550 Main St., Stratford, Conn.

Oyler, Raymond O.—Manager, Midwest region, New Departure Div., General Motors Corp., 332 S. Michigan Ave., Chicago 4, Ill.

Payne, Ralph E. — Farm sales promotion, American Sisalkraft Corp. (Mail) 1941 Arlington St., Lincoln 2, Nebr.

Price, Phillip M. — State conservation engineer, Soil Conservation Service (USDA), Temple, Texas. (Mail) 2210 N. 15th St.

Rimple, Richard E. — Chief engineer, machine design and development, Rimple Mfg. Co., 1045 Reed St., Santa Clara, Calif.

Syler, Reed M.—Assistant sales manager, agricultural and industrial div., Motor Wheel Corp. (Mail) 631 S. 21st, Maywood, Ill.

Scott, Emmett L. — General manager, Geis Irrigation Co., P.O. Box 513, York, Nebr.

Simons, Dieter—Direktor, Institut fur Landmaschinenforschung, Braunschweig-Volkenrode, Germany

Smith, Howard C. — Vice-president, sales, The Smith-Gates Corp., Plainville, Conn.

(Continued on page 214)

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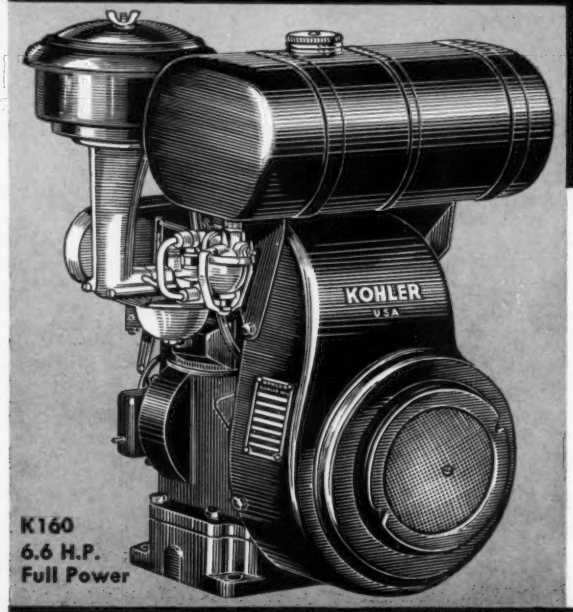

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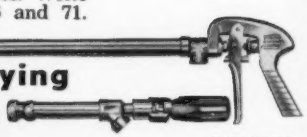

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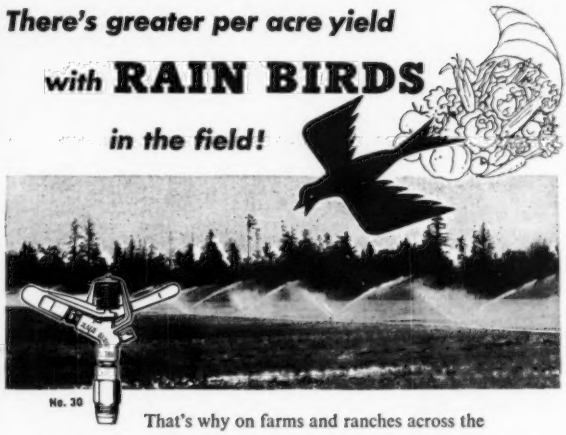

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — 1955 — AUGUST — O-324-745, 334-746, 338-747, 345-748, 346-749, 346-750, 347-751, 350-752. SEPTEMBER—O-331-754, 335-756, 352-758, 372-759. OCTOBER—O-402-762, 405-765, 409-766, 409-767, 409-768, 407-769, 407-770, 407-771, 413-772, 415-773. NOVEMBER — O-385-775, 430-776, 439-777, 451-779, 453-780, 453-781, 454-782, 448-783, 463-784, 463-785. DECEMBER — O-476-786, 503-787. 1956—JANUARY—O-455-789, 534-790, 537-791. FEBRUARY — O-4-601, 4-602, 6-603, 12-604, 15-605, 29-606, 22-607.

POSITIONS WANTED—1955—SEPTEMBER — W-351-41. OCTOBER — W-383-43, 398-45. NOVEMBER—W-428-50, 429-51, 445-52, 450-53. DECEMBER—W-458-56, 486-57, 489-58, 480-59. 1956 — JANUARY — W-457-60, 528-61, 529-62. FEBRUARY—W-506-64, 8-1, 9-2, 10-3, 14-4, 18-5, 30-6, 37-7.

NEW POSITIONS OPEN

RURAL ARCHITECT or AGRICULTURAL ENGINEER to develop designs and drawings for new farm service buildings for private company. Location in Midwest. Job offers security and good advancement opportunities. Age under 35. Farm background desirable. Degree preferred but not essential. Salary open but consistent with experience and training. O-60-608

SALES AND SERVICE ENGINEER to call on dealer accounts handling farm buildings. Degree in any agricultural field acceptable if interested in farm building efficiency, layout and sales. Age under 35. Farm background or experience needed. Location in Midwest with approximately one-half time in field. Excellent opportunities for the right man. Salary open. O-60-609

PRODUCT DESIGN ENGINEER to design and develop compatible line of farm implements, and handle related test and research work with established manufacturer in small town in Midwest. Age, under 45. BS deg in mechanical engineering, with experience in farm equipment field. Good health. Excellent opportunity for advancement. Salary $450 to $550 per month to start. List background, references and salary requirements in first letter. O-58-610

PRODUCT ENGINEER for the design and development of tillage and harvesting equipment for the southern farmer. BS in mechanical or agricultural engineering. Southern farm background and experience in the development of farm implements desirable. Excellent opportunity for a man with creative ability and a genuine interest in farm equipment design. Interested persons write qualifications, references, and enclose small, recent snapshot. O-71-611

AGRICULTURAL ENGINEER for research on better methods of handling and storing grains in commercial grain storages, with public service agency. Location Southwest. Age, under 45. BS or MS deg in agricultural engineering, with experience in research, preferably on handling or storing of grain or seed. Usual personal qualifications for research in public service. Good opportunity for advancement. GS-7 or GS-9 rating. Salary, $4930 minimum to start, or higher according to qualifications. O-80-612

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, or research in farm structures or rural electrification with industry or public service, anywhere in U.S.A. Some travel acceptable. Married. Age 26. No disability. BS deg in agricultural engineering, 1952, University of Massachusetts. MS deg in agricultural engineering, 1954, Purdue University. Dairy and general farm background. Undergraduate engineering work experience. Research assistant 2 yr while in graduate study. Army experience 2 yr, including 9 mo in electronics and radar school and 12 mo as electronic fire control system repairman. Available August 1, or possibly earlier if proposed early releases approved. Salary open. W-52-8

AGRICULTURAL ENGINEER for service work in power and machinery, preferably in Northeast. Limited travel. To be married in June. Age 22. No disability. BS deg in agricultural engineering expected June 10, University of Maine. Farm background. One summer as test engineer with farm equipment manufacturer. Part time work in college in agricultural engineering extension, drafting, and shop. Available June 25. Salary open. W-67-9

AGRICULTURAL ENGINEER for design, development, or research in power and machinery or product processing field with manufacturer or processor, preferably in upper Midwest. Married. Age 29. No disability. BS deg in agricultural engineering, 1950, University of Minnesota. Farm background. Oiler on gas-driven generators in steel mill, 6 mo. Draftsman and test engineer with refrigeration manufacturer, 3 yr. Test engineer with farm equipment manufacturer 2½ yr, on combines and corn pickers. War enlisted service in Navy, 2 yr. Available on 2 to 4 weeks notice. Salary open. W-55-10

Applicants for Membership

(Continued from page 210)

Smith, James E.—Farm representative, Central Hudson Gas and Electric Co., Poughkeepsie, N. Y.

Stevenson, Joseph S.—Farm building dept., Honeggers and Co., Inc. (Mail) RR 4, Streator, Ill.

Terry, LeGrand E. —Sales, Vickers, Inc. (Mail) 934 Graefield Rd., Birmingham, Mich.

Utter, Donald E. — Cartographer (topographic), U.S. Geological Survey, Box 197 (T&C), Sacramento 21, Calif.

Wells, Norman F. — Student training program, engineering dept., J. I. Case Co., (Mail) Alicel, Oregon

Willey, Eric A. — Product test engineer, tractor and implement div., Ford Motor Co. (Mail) 435 LeRoy Ave., Clawson, Mich.

Williams, Edred B.—Product design engineer, tractor and implement div., Ford Motor Co. (Mail) 2648 Pembroke, Birmingham, Mich.

Wilson, Charles W. — Assistant county agent, South Carolina Extension Service. (Mail) P.O. Box 167, Campus, Sta., Athens, Ga.

Wyborny, Leslie C.—Agricultural engineer, Soil Conservation Service. (Mail) Box 488, Hot Springs, S. Dak.

Transfer of Membership

Funderburg, J. Mark — Design engineer, The Oliver Corp., South Bend, Ind. (Mail) 1612 S. St. Joseph St., South Bend 14, Ind. (Associate Member to Member)

Horning, Theodore R.—Agricultural engineer, ARS, USDA, Pendleton Branch Experiment Station, Pendleton, Oregon. (Mail) 724 N. W. Johns Place. (Affiliate to Member)

Matson, Walter E.—Assistant professor and assistant agricultural engineer, agricultural engineering dept., State College of Washington, Pullman, Wash. (Associate Member to Member)

Morgan, Moses J.—Assistant professor and assistant argicultural engineer, agricultural engineering dept., State College of Washington, Pullman, Wash. (Associate Member to Member)

Reaves, Carl A. — Agricultural engineer, USDA Tillage Machinery Laboratory, P.O. Box 792, Auburn, Ala. (Associate Member to Member)

Zachariah, P. John — Graduate assistant in agricultural engineering dept., West Virginia University, Morgantown, W. Va. (Associate Member to Member)

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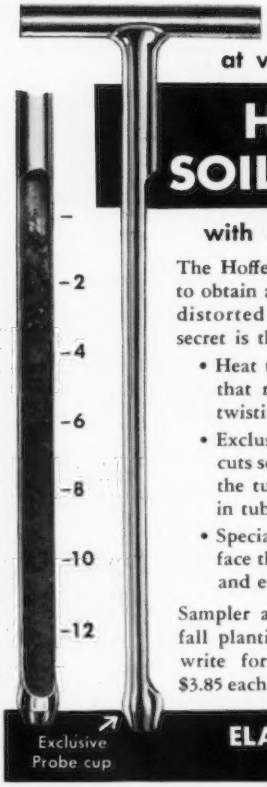

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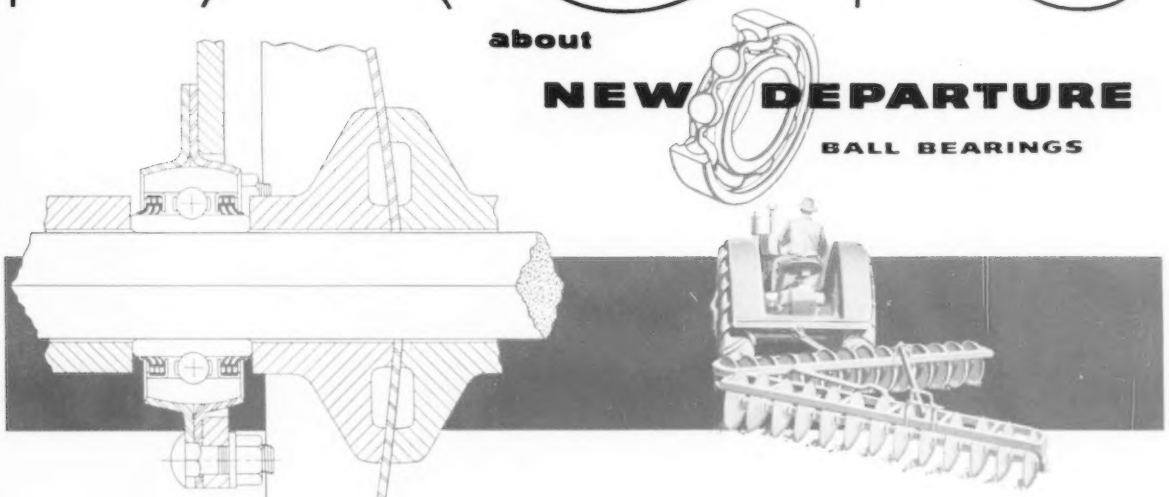

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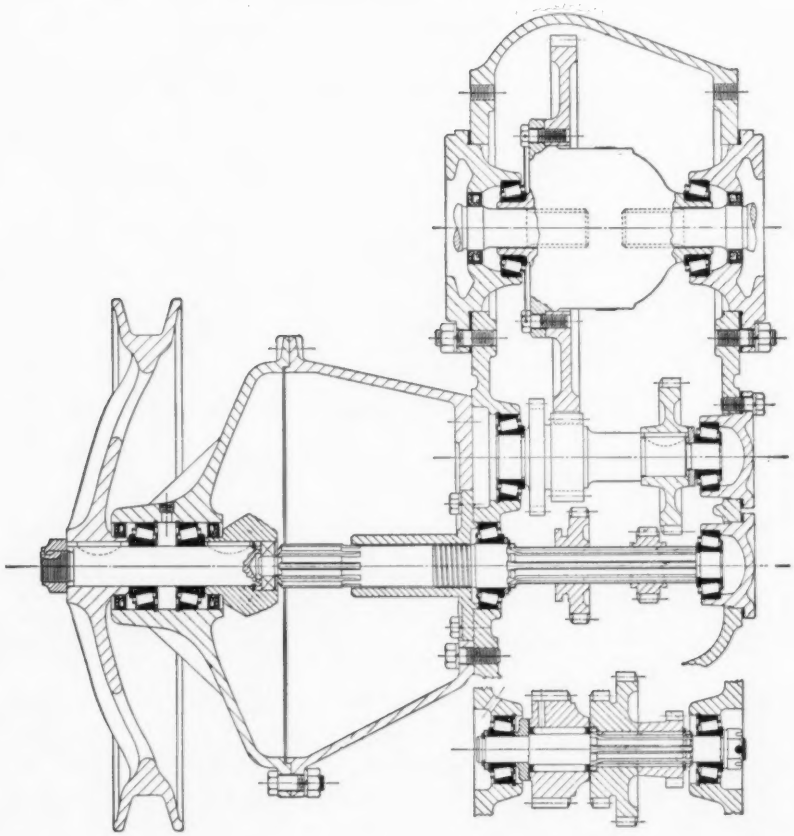
How John Deere Designs Smooth Shifting Into Its Combine Transmission



SINCE rigid shaft alignment is the best way to insure accurate gear meshing and smooth shifting, John Deere engineers mount gear shafts in their combine transmission on Timken® tapered roller bearings.

Timken bearings hold shafts in rigid alignment because tapered construction enables them to take radial and thrust loads in any combination. Line contact between rollers and races in Timken bearings insures load-carrying capacity to spare. Shafts can't get out of line, gears mesh smoothly, wear less.

Using Timken bearings, John Deere engineers can count on power savings, too. The true rolling motion and extremely smooth finish of Timken bearings practically eliminate friction. And since Timken bearings keep housings and shafts concentric, closures are more effective. Lubricant stays in, dirt and moisture stay out.

By using Timken bearings, agricultural engineers can solve three of their biggest design problems: 1) combination loads, 2) dirt, 3) ease of operation. Timken bearings can be counted on to make equipment operate more easily, last longer. And they're made of the best bearing steel available. To make sure it's the best, we make our own—the only U. S. bearing manufacturer that does.

Write for your copy of "Tapered Roller Bearing Practice in Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design

Tapered Roller TIMKEN BEARING EQUIPPED

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION